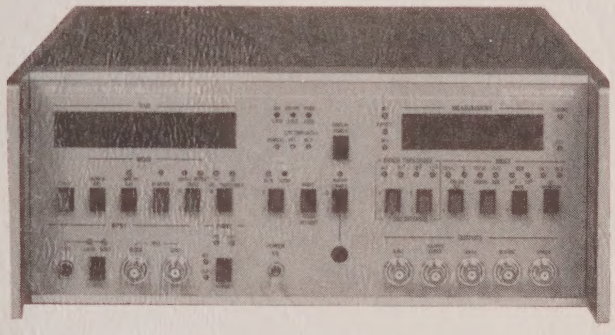
MAINTENANCE MANUAL

Model 4657
DS3 Error Rate Analyzer



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Scientific Atlanta

Model 4657
DS3 Error Rate Analyzer

Maintenance Manual

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INSTRUMENTATION

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OVERVIEW

0.1 INTRODUCTION

The Scientific-Atlanta Model 4657 Error Rate Analyzer is supplied with two manuals: the Operator's and the Maintenance. This Maintenance manual provides technical information such as theory of operation, service maintenance procedures, parts listings, printed circuit board layouts and schematics, and is designed to be used in conjunction with the Operator's manual. However, some of the more frequently referred to information (from the Operator's manual) is reprinted in this Overview section in case the Operator's manual is not readily available.

NOTE

Maintenance or service of this equipment must be performed only by trained service personnel who are aware of the hazards involved, such as fire and electrical shock.

0.2 TECHNICAL SPECIFICATIONS

B3ZS Input (bipolar signal)	
Rate:	44.736 (±0.1) Mbit/S
Impedance:	75 ohms
Return loss:	Greater than 20 dB for a 3 nS rise time pulse
Connector:	Accepts a WECo 440 type
Sensitivity:	Switch selectable (HI/LO and DSX-3) to match the available signal: HI/LO: Operates to 22 dB below DSX level

Sensitivity (con't):	DSX-3: Provides compensation for a DS3 data signal passed through 450 feet of type 728A cable
Pulse Characteristics	
Width:	11.2 (±1.1) nS
Rise/fall:	4.5 (±1.5) nS
Signal Format:	Bipolar B3ZS with or without DS3 framing bits
NRZ Input (unipolar signal)	
INPUT - CLOCK	
Connector:	BNC type
Impedance:	75 ohms, ac coupled
Frequency:	10 to 46 MHz, 1.0 to 2.0 volts peak-to-peak
INPUT - DATA	
Connector:	BNC type
Impedance:	75 ohms, dc coupled, selectable for 10K type ECL, TTL, or 2 volt bipolar centered about 0 volts. Level and data polarity selection is by means of an internal jumper.
Signal format:	Unipolar NRZ with or without DS3 framing structure
INPUT - DC Monitor	
Connector:	9 pin D-type
DC Voltage:	Two inputs accomodate voltages from -40.00V dc to +40.00V dc.
Dry Contact:	Two inputs sense open- and short-circuit.
Synchronization (any input type)	
Framing:	Automatically accomodates to data patterns with or without the framing structure by searching for a PRBS pattern if unable to detect framing. This search operation is disabled during a test.
Definitions:	
"In Sync":	F-Frame = 15 successive F-bits agree with the predicted pattern M-Frame = 2 successive "010" sequences are found
"Out of Sync":	F-Frame = 3 out of 15 F-bits are incorrect M-Frame = 2 out of 3 "010" sequences are in error

Measurement Modes	
Types of Errors:	Measurements are concurrently made on the three possible error types, any one of which may be selected for display.
Bit Errors:	Detected by comparing the incoming data pattern with the output of an internal PRBS generator (available only with PRBS data pattern)
Parity Errors:	Detected by comparing the incoming parity bits with internally computed parity (available only with framed data)
Bipolar Violations:	Detected by keeping track of the alternate mark inversion sequence in incoming B3ZS data (not available with NRZ)
Error Measurements:	From the acquired data, several measurement values may be computed for display
Bit Error Rate (BER) Per 10^7 Bits:	Counts the number of errors in a sample of 10^7 bits and divides the result by 10^7, updating the display every 0.22 seconds
Bit Error Rate (BER) Per 10^8 Bits:	Counts the number of errors in a sample of 10^8 bits and divides the result by 10^8, updating the display every 2.2 seconds
Error Threshold:	During a timed test, one of 4 selectable error thresholds is used to classify error-seconds data: ALL (0), 10^{-7}, 10^{-6}, and 10^{-3}. To be counted at a given threshold, an error must fall in a one-second interval for which the BER exceeds the selected threshold. The one-second intervals may be synchronized to incoming errors (SYNCHRONOUS ERROR-SECONDS) or be tied to the internal clock (ASYNCHRONOUS ERROR-SECONDS) by means of an internal jumper.
Total Error-Seconds:	Number of seconds during the timed test for which the BER exceeded the selected threshold.
% Error Seconds:	Error-Seconds expressed as a percentage of seconds in the test.
Total Errors:	Total number of errors which occurred during Error-Seconds for which the BER exceeded the selected threshold since the start of the test.

Average Bit Error Rate (BER):	Total errors exceeding the selected threshold divided by the total number of bits received during a test.
Error Bursts:	Available only with 4650 Printer or one of the remote interfaces (IEEE-488 or RS-232C). An error burst is a group of one or more contiguous "Error Milliseconds". The number of bursts in each of three length catagories is tabulated (1-9, 10-99, and > 100) for the error type selected when entering RUN mode.
Frame Loss Seconds:	Available only with 4650 Printer or one of the remote interfaces (IEEE-488 or RS-232C). When a frame loss is encountered, the loss seconds are counted. The data from these seconds is excluded from all other error measurements except 10^{-7} BER and 10^{-8} BER. If there is frame loss when entering RUN mode, this feature is disabled.
Signal Loss Seconds:	Available only with 4650 Printer or one of the remote interfaces (IEEE-488 or RS-232C). When a signal loss is encountered, the loss seconds are counted. The data from these seconds is excluded from all other error measurements except 10^{-7} BER and 10^{-8} BER.
DC Monitor:	Two DC VOLTAGE inputs and two DRY CONTACT inputs can be monitored. The first display position in the MEASUREMENT DISPLAY contains the status of the selected DRY CONTACT input (blank = Inactive, A = Active, and H = has been active during the timed test). The remainder of the display shows DC VOLTAGE for the selected input. If the 4650 Printer or one of the remote interfaces is also available, out of threshold seconds for each channel is available along with the error quantities of each type for each channel out of threshold.
Indicators	
PRBS Frame Loss:	On when synchronization between the local PRBS generator and the incoming data pattern is not achieved. (More than 1023 errors in 32767 bits.)
Gating:	On, indicates that a measurement is underway. Blinks to indicate display update.

Signal Loss:	On when input data is lost for more than 100 mS
Frame Loss:	On when framing is not present in the input signal, or was not present when a timed test was begun.
Remote:	On when a remote device is controlling the 4657 Analyzer via the IEEE-488 or RS-232C option.
Run/Stop:	Red indicates Stop mode; green indicates Run mode. If, during a timed test (Run mode) a test fault condition is encountered (power loss, signal loss, frame loss, PRBS loss, DC out of threshold, or dry contact alarm), the green Run indicator will flash. When the test ends or is stopped, the respective indicators will flash, with the red Stop indicator flashing to indicate power loss.
IN 1 and IN 2 Out of Threshold:	On when DC VOLTAGE for respective input exceeds programmed upper threshold or is less than programmed lower threshold.
Time Display:	Seven-digit numeric display shows time of day, month/day, elapsed time, or time remaining in test, as indicated by the associated mode indicators. Timekeeping is accomplished by means of a real-time clock circuit which is backed up by a Ni-Cad battery to permit timekeeping in the absence of external power, and recovery upon re-application of power. Voltage thresholds from -40.00 to 40.00 may be entered in the TIME display for the DC MONITOR function.
Measurement Display:	
Error Rates	1.0000 to 1.0×10^{-50}
Counts (error-seconds and total errors)	0 to 999,999 in decimal notation then 1.000×10^{6} to 9.99×10^{50} in scientific notation.
DC Monitor	Leftmost display position is status of selected DRY CONTACT input (blank = Inactive, A = Active, H = has been active during the test). Rest of display is DC voltage from -40.00 to 40.00. Input 1 data is displayed only if DC MONITOR IN 1 is selected and input 2 data is displayed only if DC MONITOR IN 2 is selected.

Measurement Ranges	
Bit Errors and Bipolar Violations:	2.0×10^{-3} to 1.0×10^{-50}
Parity Errors:	2.1×10^{-4} (all errors) to 1.0×10^{-50}
Total Errors, Error-Seconds	0 to 999×10^{50}
DC Voltage:	-40.00 to +40.00
BLUE Signal display:	The characters "BLUE" in the measurement display in the RUN mode and BIT ERROR mode.
General Features	
Power Supply:	Operates from either line voltage of 115/220V ac (±10%), 50 to 60 Hz, or station battery of -22V dc to -60V dc with positive ground.
Power Dissipation:	70 Watts
Weight:	10.9 kilograms (24 pounds)
Dimensions:	33.0 cm W x 38.1 cm D x 13.3 cm H (13 in. W x 15 in. D x 5.25 in. H)
Temperature:	Operating: 0° to +50°C Storage: -20° to +50°C

Model 4650 Printer (Optional)

Interface Format:	Parallel input, eight-bit-parallel/charcter serial, standard ASCII format, 21 characters/ line
Modes:	ALL or Partial printout modes selectable on the 4657 Analyzer (displays Error Burst Data in ALL mode). For tests greater than five minutes, summary printouts (test ending and force prints) will be ALL format. Conditions which trigger printout selectable on the 4657 Analyzer front panel. Printout may be triggered by (a) Bit Error Rate greater than selected threshold, a frame loss second, or a signal loss second, (b) a DC Voltage input going out of threshold, or (c) any of these conditions. Logs on Error-Second until 10 continuous Error-Seconds are encountered.

	Logs on PRINT command from front panel of the 4657 Analyzer. Logs at end of test.
Power	Derived from the 4657 Analyzer through interface cable.

0.3 FRONT AND REAR PANEL CONFIGURATION

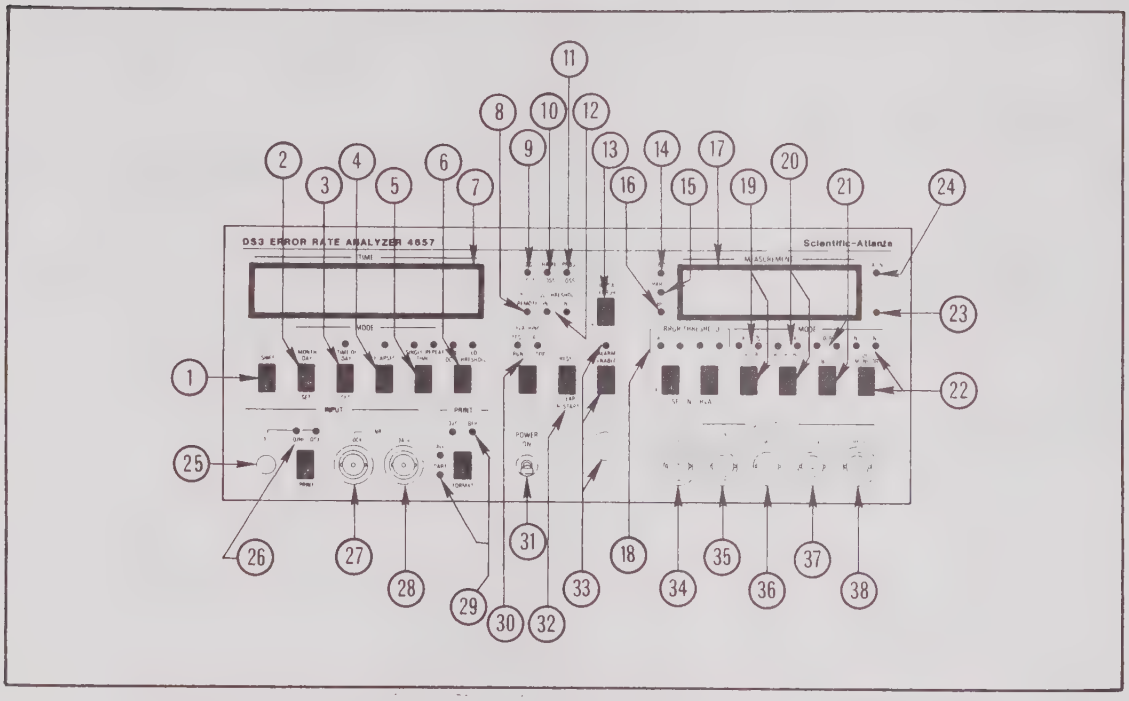


Figure 0.1. Model 4657 Analyzer Front Panel Configuration

1. SHIFT Switch
2. (TIME MODE) MONTH-DAY Switch
3. (TIME MODE) TIME OF DAY Switch and Indicator
4. (TIME MODE) ELAPSED Switch and Indicator
5. (TIME MODE) SINGLE and REPEAT TIMED Switch and Indicator
6. HI and LO DC THRESHOLD Switch and Indicator
7. TIME Display
8. REMOTE Indicator
9. SINGLE LOSS Indicator
10. FRAME LOSS Indicator
11. PRBS LOSS Indicator
12. DC THRESHOLD IN 1 and IN 2 Indicators
13. DISPLAY ERROR Switch
14. BIT Indicator
15. PARITY Indicator
16. BPV Indicator
17. MEASUREMENT DISPLAY
18. ERROR THRESHOLD Switches and Indicators
19. (MEASUREMENT MODE) TOTAL or % ERROR SEC Switch and Indicators
20. (MEASUREMENT MODE) TOTAL ERROR or AVG BER Switch and Indicators
21. (MEASUREMENT MODE) BER 10^7 or 10^8 BITS Switch and Indicators
22. (MEASUREMENT MODE) DC MONITOR IN 1 or IN 2 Switch and Indicators
23. DCV Indicator
24. GATING Indicator
25. DS3 INPUT Connector
26. (INPUT) LO/HI or DSX Switch and Indicators
27. (INPUT) NRZ CLOCK Connector
28 (INPUT) NRZ DATA Connector
29. (PRINT) DCV or BER, ALL or PART FORMAT Switch and Indicators
30. RUN/STOP Switch and Indicators
31. POWER ON Switch
32. RESET/CLEAR Switch
33. ALARM ENABLE Switch and Indicator

34-38. OUTPUT Connectors

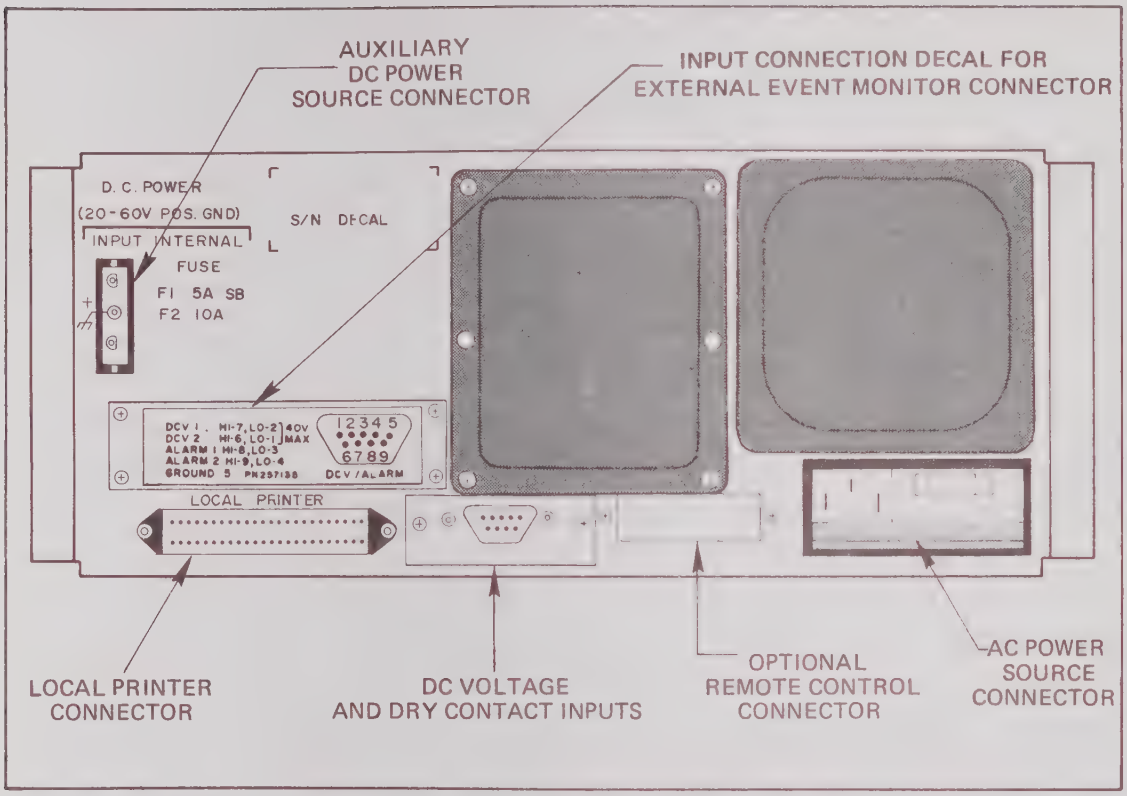


Figure 0.2. Model 4657 Analyzer Rear Panel Configuration

CHAPTER 4
THEORY OF OPERATION

4.1 GENERAL

Theory of operation for the Model 4657 Error Rate Analyzer system is presented in two parts; part one describes the power supply, while part two describes features and functions. The power supply is described in a separate section because the dc supply used in this system operates independently from the other circuits.

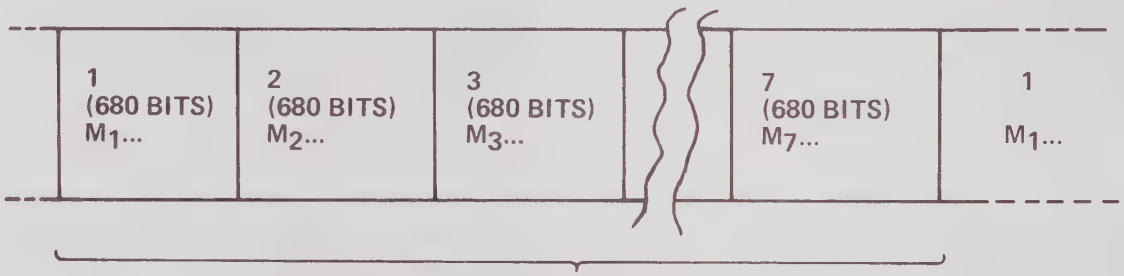
The Model 4657 Analyzer receives Bell System DS3 formatted digital signal in either a bipolar with 3-zero substitution arrangement or a non-return to zero (NRZ) arrangement with separate clock and data lines. Figure 4.1 outlines key features of the DS3 signal format on which the Model 4657 Analyzer operates. Within this format, a transmitter (the Model 4651A for instance) can send a data pattern of all 1's, all 0's, alternate 1's and 0's (...10101...), or a repeating pseudo random bit sequence (PRBS) of 32767 bits. The selected data pattern alone can be sent by disabling the framing bits. The analyzer, in turn, is capable of determining the presence or absence of a framing pattern and locking onto a PRBS or alternating 1's and 0's pattern. If the PRBS is detected, bit errors are measured, while the ...10101... pattern results in a "BLUE" signal display. If framing is present, parity errors are detected and measured. This feature makes it possible to measure error rates on live traffic.

The Model 4657 Analyzer provides two dc voltage inputs for measuring the AGC voltage, and two "dry contact" inputs for monitoring the status of the alarms. Thresholds for the dc inputs are programmable such that any excursions above or below the selected threshold points will actuate a front panel indicator and trigger a printout on the Model 4650 Printer.

TYPICAL 680 BIT DISTRIBUTION PER F-FRAME OF DATA SIGNAL

Mn	84I	F_1	84I	C_i	84I	F_0	84I	C_i	84I	F_0	84I	C_i	84I	F_1	84I

LEGEND: Mn; WHERE n = 1, 2, 3, 4, 5, 6, OR 7
F_1, F_0, F_0, F_1; LOCATION OF BITS 1, 0, 0, 1
C_i ; LOCATION OF EITHER A "111" OR A "000"
84I; LOCATION OF 84 INFORMATION BITS



TYPICAL 4760 BIT DISTRIBUTION PER SUPERFRAME

LEGEND: M_1, M_2, THROUGH M_7 = XXPP010
(NOTE THAT ONLY ONE M-BIT OCCURS PER F-FRAME SEQUENCE.)
WHERE: XX REPRESENTS EITHER 00 or 11,
PP REPRESENTS EVEN PARITY FOR 4760 DATA BITS,
$C_iC_iC_i$ REPRESENTS EITHER 111 or 000 WITHIN AN F-FRAME.
(C BITS WITHIN AN F-FRAME ARE THE SAME AND HAVE THE PATTERN OF 001001001001001011 OVER AN 18 F-FRAME SEQUENCE.)

OPERATIONAL NOTES:

1. PARITY IS CALCULATED ON THE INFORMATION BITS FROM M_1 TO M_1. THIS CALCULATION IS THEN INSERTED INTO M_3 AND M_4 IN THE FOLLOWING SUPERFRAME. PARITY BITS ARE 11 FOR THE SUM OF I-BITS EQUAL TO 1, AND 00 FOR THE SUM OF I-BITS EQUAL TO 0.
2. THE ANALYZER DECLARES F-BITS ARE "IN-FRAME" WHEN 15 SUCCESSIVE F-BITS AGREE WITH THE PREDICTED PATTERN, AND DECLARES "OUT-OF-FRAME" WHEN 3 OUT OF 15 F-BITS ARE INCORRECT.
3. THE ANALYZER DECLARES M-BITS ARE "IN-FRAME" WHEN TWO SUCCESSIVE "010" SEQUENCES ARE FOUND, AND DECLARES "OUT-OF-FRAME" WHEN 2 OUT OF 3 "010" SEQUENCES ARE INCORRECT.

Figure 4.1. DS3 Format

4.2 DC SUPPLY

Source power for the Model 4657 Analyzer may be supplied from a 115V/220V, 50/60 Hz ac line and/or from a -22V to -60V dc, positive ground, Station Battery connection. Either source can provide the internal dc voltage required to operate the Pulse Width Modulator power supply circuits. The Pulse Width Modulator provides a switching-type power source that has high efficiency, low weight, and versatile operating voltages. If both ac and dc sources are connected to their respective inputs, the ac is transformer reduced and rectified to approximately -55 volts dc. The two dc sources are "diode-ORed" to allow the highest source potential to drive the power supply circuits.

A. AC/DC Input Power Source

Figure 4.2 is a block diagram of input power source distribution for the Model 4657 Analyzer. The rear panel schematic is shown in Figure 7.38. Both sides of the ac power source (hot and neutral) are switch interrupted and the third wire safety ground is connected directly to the chassis. The applied ac is reduced through transformer T1 to approximately 32 volts ac RMS which is rectified by diode bridge CR3 on the Rectifier and Filter Assembly PCB. The output voltage from CR3 is a nominal -55V dc which is filtered by capacitors C4 and C5 and applied to one terminal of diode bridge CR2.

If a Station Battery dc source of -22V to -60V (positive ground) is applied to the rear panel DC INPUT connector (J1), both the source and the equipment are fuse protected (F1 and F2 on the Rectifier and Filter Assembly PCB). The negative source line is interrupted by contacts of the front panel POWER ON switch. When closed, the switch contacts apply the battery source voltage through a current limiting circuit and a filter network of L1, C1, C2, and C3 to a terminal of diode bridge CR2. The filter network removes induced noise components and transients from reflecting into the Station Battery source. A diode, CR1, is part of this filtering network and also provides protection should the Station Battery source polarity be accidentally reversed.

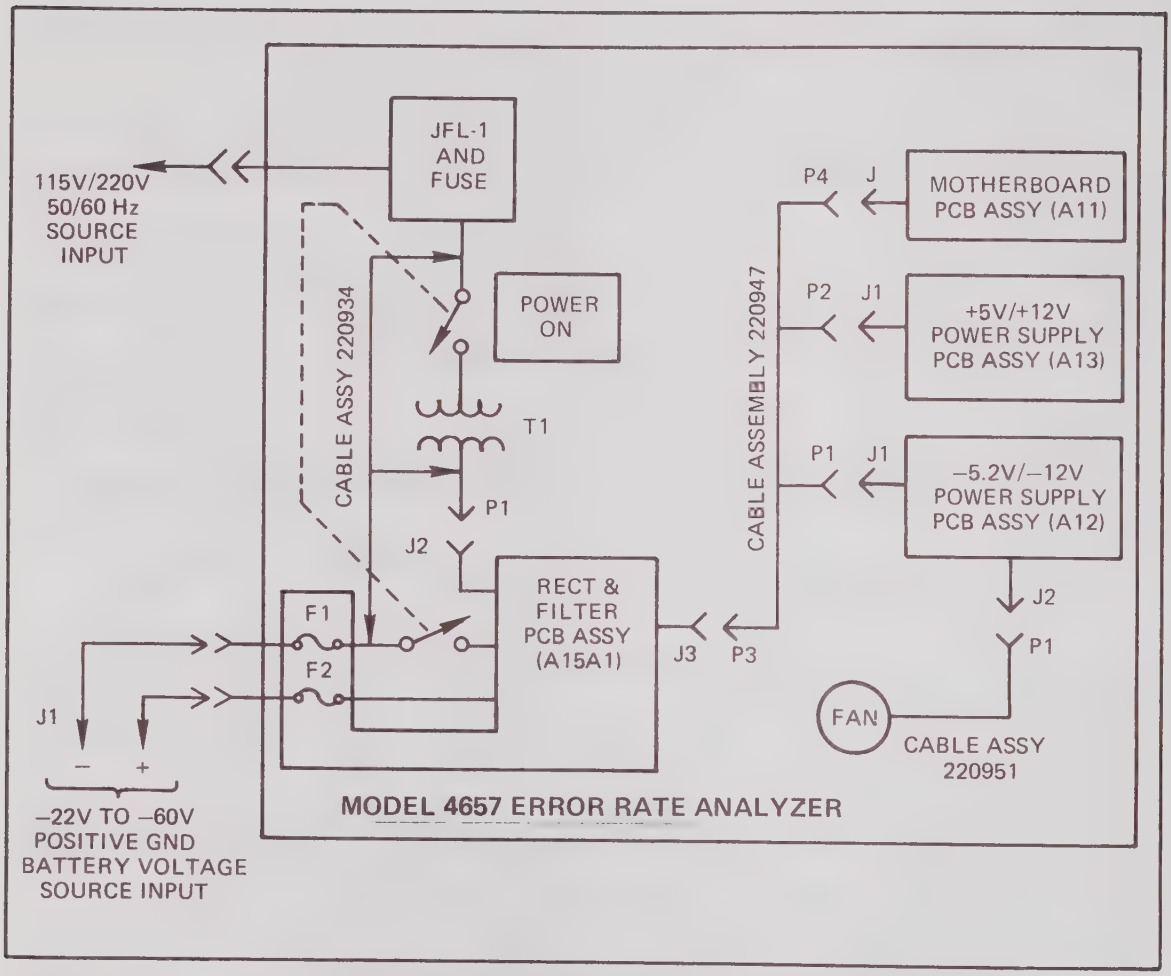


Figure 4.2. **Model 4657 Analyzer, Input Power Source Distribution, Block Diagram**

The two dc sources are connected at specific terminals of diode bridge CR2. The source having the larger potential will be passed by its respective diode in the CR2 bridge and reverse biasing the opposite source diode from conduction. In this manner, the two power sources are diode OR'ed, the larger potential supplying operating power, and the lower potential in ready reserve if needed.

B. -5.2V/-12V DC Power Supply Printed Circuit Board Assembly

The -5.2V/-12V DC Power Supply PCB uses a pulse width modulation circuit where varying the duty cycle of a fixed frequency pulse stream produces an

adjustable regulated dc voltage output. The output is sensed and fed back into the pulse width modulator which controls pulse width as needed to maintain a constant voltage. A block diagram of the -5.2V/-12V DC Power Supply PCB Assembly is shown in Figure 4.3. Components U1 and U3 each contain all the active circuitry necessary to implement a pulse width modulator except for the power switching transistor. Components used with U1 or U3 are necessary to set the desired operating frequency, provide voltage adjustment, or other supporting functions. Other circuitry included on the PCB assembly provide for overvoltage protection, voltage regulation, and feedback control. In summary, a -22V to -60V dc input is switched through power transistors under control of a pulse width modulator to produce regulated -5.2V and -12.0V dc source supplies.

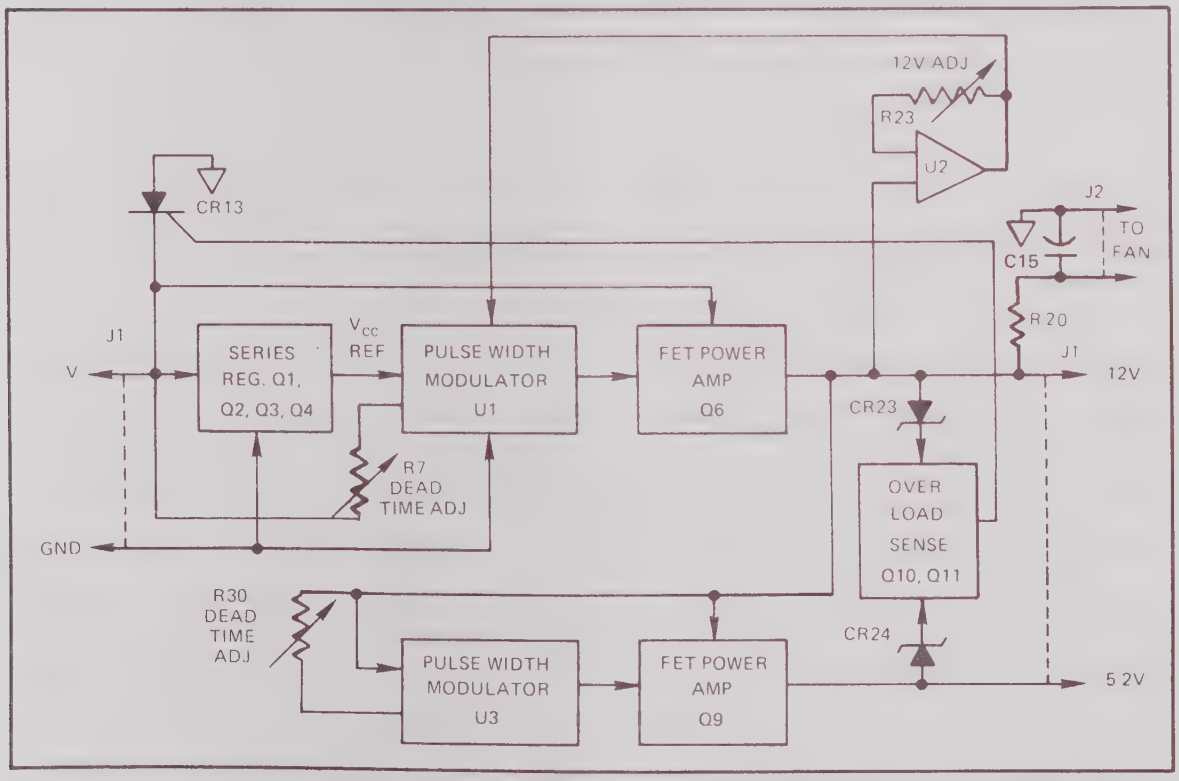


Figure 4.3. The -5.2V/-12V DC Power Supply PCB Assembly, Block Diagram

Series Regulator Circuit. The schematic diagram for the -5.2V/-12V DC Power Supply PCB Assembly is shown in Figure 7.23. A regulated voltage is required to operate a pulse width modulator circuit and the applied source

voltage of -22V to -60V must be regulated to supply a nominal 12V to pulse width modulator U1. Transistors Q1 through Q4 and associated components are connected as a series regulator producing a 12V output for U1. Note that the "-V" input in common to the series regulator circuit and the pulse width modulator and the regulator output (measured at test point TP1) will be +12 volts higher than the applied -22V to -60V input and not referenced to ground. The diode CR5 provides reverse voltage protection, and zener diode CR6 provides overvoltage protection for U1.

-12V DC Switching Regulator. All regulated dc sources produced by the power supplies use an SG3524 (or equivalent) Pulse Width Modulator component. A typical data sheet specifying the parameters of the SG3524 are provided in Figure 4.4 (8 sheets) and should describe the internal operation. The following description details the external component connections and their respective interaction with the Pulse Width Modulator (hereafter referred to as the PWM).

The PWM provides an internally stabilized reference voltage at pin 16 which is used as reference for "Dead Time Adjust" as well as several bias voltages. The "Dead Time Adjust"corresponds to the time when the PWM outputs are forced OFF. This is required in push-pull arrangements to guarantee both outputs cannot be ON simultaneously. When used as a single-ended drive (see Figure 7.23), "Dead Time Adjust" establishes the maximum output current by setting the maximum duty cycle. Variable resistor R7 (Dead Time Adjust for U1) is properly set by operating the -5.2V/-12V Power Supply PCB into a full load with a minimum input voltage (-22V dc). Variable resistor R7 is adjusted with minimum input voltage (-22V dc) clockwise to a point where the reference voltage (at U1, pin 16) starts going out-of-regulation and then is reversed two turns counterclockwise. The reference voltage is also divided by resistors R10 and R11 to bias the unused "plus" input of the internal amplifier (U1, pin 2) to an acceptable midrange point. The reference voltage is divided by resistors R16 and R17 to establish the current limit reference (U1, pin 5) to approximately 3.5 Amperes. Components R8 and C6 will hold the PWM outputs OFF momentarily on initial power-up to allow voltages to stabilize before the PWM begins to regulate.

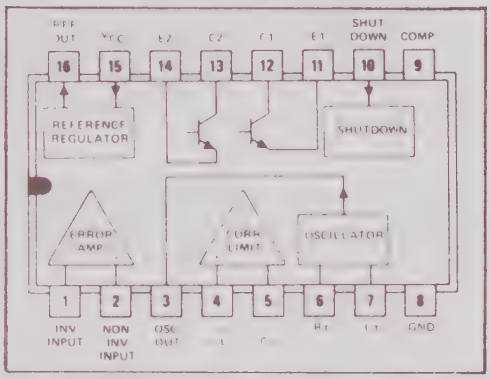
LINEAR INTEGRATED CIRCUITS

TYPES SG1524, SG2524, SG3524 REGULATING PULSE WIDTH MODULATORS

BULLETIN NO. DL-S 12495, APRIL 1977

- Complete PWM Power Control Circuitry
- Uncommitted Outputs for Single-Ended or Push-Pull Applications
- Low Standby Current . . . 8 mA Typ
- Interchangeable With Silicon General SG1524, SG2524, and SG3524, Respectively

SG1524 . . . J
SG2524, SG3524 . . . J OR N
DUAL IN-LINE PACKAGE (TOP VIEW)

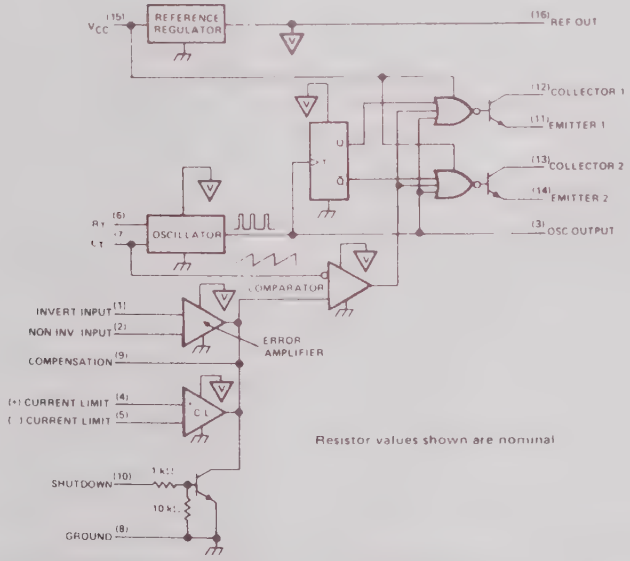


description

The SG1524, SG2524, and SG3524 incorporate on single monolithic chips all the functions required in the construction of a regulating power supply, inverter, or switching regulator. They can also be used as the control element for high-power-output applications. The SG1524 family was designed for switching regulators of either polarity, transformer-coupled dc-to-dc converters, transformerless voltage doublers, and polarity converter applications employing fixed-frequency, pulse-width-modulation techniques. The complementary output allows either single-ended or push-pull application. Each device includes an on-chip regulator, error amplifier, programmable oscillator, pulse-steering flip-flop, two uncommitted pass transistors, a high-gain comparator, and current-limiting and shut-down circuitry.

The SG1524 is characterized for operation over the full military temperature range of −55°C to 125°C. The SG2524 and SG3524 are characterized for operation from 0°C to 70°C.

functional block diagram



Resistor values shown are nominal

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Figure 4.4. Pulse Width Modulator SG3524, Data Sheets (Sheet 1 of 8)

TYPES SG1524, SG2524, SG3524
REGULATING PULSE WIDTH MODULATORS

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply Voltage, V_{CC} (See Notes 1 and 2) . . . . . 40 V
Collector Output Current . . . . . 100 mA
Reference Output Current . . . . . 50 mA
Current Through C_T Terminal . . . . . −5 mA
Continuous Total Dissipation at (or below) 25°C Free-Air Temperature (See Note 3) . . . . . 1000 mW
Operating Free-Air Temperature Range: SG1524 . . . . . −55°C to 125°C
SG2524, SG3524 . . . . . 0°C to 70°C
Storage Temperature Range . . . . . −65°C to 150°C

NOTES: 1. All voltage values are with respect to network ground terminal
2. The reference regulator may be bypassed for operation from a fixed 5 volt supply by connecting the V_{CC} and reference output pins both to the supply voltage. In this configuration the maximum supply voltage is 6 volts.
3. For operation above 25°C free-air temperature, see Dissipation Derating Curves, page 124.

recommended operating conditions

	SG1524		SG2524, SG3524		UNIT
	MIN	MAX	MIN	MAX	
Supply voltage, V_{CC}	8	40	8	40	V
Reference output current	0	50	0	50	mA
Current thru C_T terminal	−0.03	−2	−0.03	−2	mA
Timing resistor, R_T	1.8	100	1.8	100	kΩ
Timing capacitor, C_T	0.001	0.1	0.001	0.1	μF
Operating free-air temperature	−55	125	0	70	°C

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 20 V, f = 20 kHz (unless otherwise noted)

reference section

PARAMETER	TEST CONDITIONS†	SG1524			SG2524			SG3524			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	
Output voltage		4.8	5	5.2	4.8	5	5.2	4.6	5	5.4	V
Input regulation	V_{CC} = 8 to 40 V		10	20		10	20		10	30	mV
Ripple rejection	f = 120 Hz		66			66			66		dB
Output regulation	I_O = 0 to 20 mA		20	50		20	50		20	50	mV
Output voltage change with temperature	T_A = MIN to MAX		0.6	2		0.3	1		0.3	1	%
Short-circuit output current §	V_{ref} = 0		100			100			100		mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values except output voltage change with temperature are at T_A = 25°C.
§ Duration of the short-circuit should not exceed one second.

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Figure 4.4. Pulse Width Modulator SG3524, Data Sheets (Sheet 2 of 8)

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 20 V, f = 20 kHz (unless otherwise noted)

error amplifier section

PARAMETER	TEST CONDITIONS	SG1524, SG2524			SG3524			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
Input offset voltage	V_{IC} 2.5 V		0.5	5		2	10	mV
Input bias current	V_{IC} = 2.5 V		2	10		2	10	μA
Open-loop voltage amplification		72	80		60	80		dB
Common-mode input voltage range	T_A = 25°C	1.8 to 3.4			1.8 to 3.4			V
Common-mode rejection ratio			70			70		dB
Unity-gain bandwidth			3			3		MHz
Output swing	T_A 25°C	0.5		3.8	0.5		3.8	V

oscillator section

PARAMETER	TEST CONDITIONS†	MIN	TYP‡	MAX	UNIT
Frequency	C_T = 0.001 μF, R_T = 2 kΩ		450		kHz
Standard deviation of frequency§	All values of voltage, temperature, resistance, and capacitance constant		5		%
Frequency change with voltage	V_{CC} = 8 to 40 V, T_A = 25°C			1	%
Frequency change with temperature	T_A MIN to MAX			2	%
Output amplitude at pin 3			3.5		V
Output pulse width at pin 3	C_T 0.01 μF		0.5		μs

comparator section

PARAMETER	TEST CONDITIONS	MIN	TYP‡	MAX	UNIT
Maximum duty cycle, each output		45			%
Input threshold voltage at pin 9	Zero duty cycle		1		V
	Maximum duty cycle		3.5		
Input bias current			-1		μA

current limiting section

PARAMETER	TEST CONDITIONS	SG1524, SG2524			SG3524			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
Input voltage range (either input)		-0.7 to +1			-0.7 to +1			V
Sense voltage for 2-V output at pin 9	V(pin 2) − V(pin 1) ≥ 50 mV, T_A = 25°C	190	200	210	180	200	220	mV
Sense voltage	T_A = MIN to MAX		0.2			0.2		mV/°C

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values except for temperature coefficients are at T_A = 25°C.

§Standard deviation is a measure of the statistical distribution about the mean as derived from the formula $\sigma = \sqrt{\frac{\sum (X_n - X)^2}{N - 1}}$

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Figure 4.4. Pulse Width Modulator SG3524, Data Sheets (Sheet 3 of 8)

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 20 V, f = 20 kHz (unless otherwise noted)

output section

PARAMETER	TEST CONDITIONS	MIN	TYP‡	MAX	UNIT
Collector-emitter breakdown voltage		40			V
Collector off-state current	V_{CE} = 40 V		0.01	50	μA
Collector-emitter saturation voltage	I_C = 50 mA		1	2	V
Emitter output voltage	V_C = 20 V, I_E = −250 μA	17	18		V
Turn-off voltage rise time	R_C = 2 kΩ		0.2		μs
Turn-on voltage fall time	R_C = 2 kΩ		0.1		μs

total device

PARAMETER	TEST CONDITIONS	MIN	TYP‡	MAX	UNIT
Standby current	V_{CC} = 40 V, Pin 2 at 2 V, Pins 1,4,7,8,9,11,14 grounded, All other inputs and outputs open		8	10	mA

‡All typical values except for temperature coefficients are at T_A = 25° C

PARAMETER MEASUREMENT INFORMATION

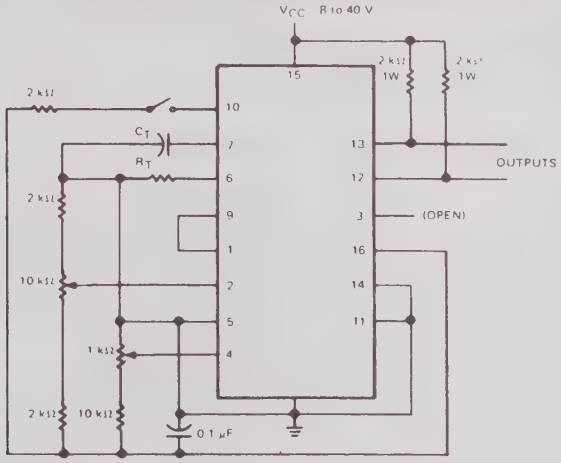
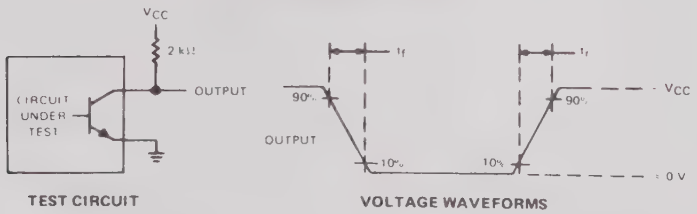


FIGURE 1—GENERAL TEST CIRCUIT



TEST CIRCUIT VOLTAGE WAVEFORMS

FIGURE 2—SWITCHING TIMES

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Figure 4.4. Pulse Width Modulator SG3524, Data Sheets (Sheet 4 of 8)

TYPICAL CHARACTERISTICS

OPEN LOOP VOLTAGE AMPLIFICATION
OF ERROR AMPLIFIER
vs
FREQUENCY

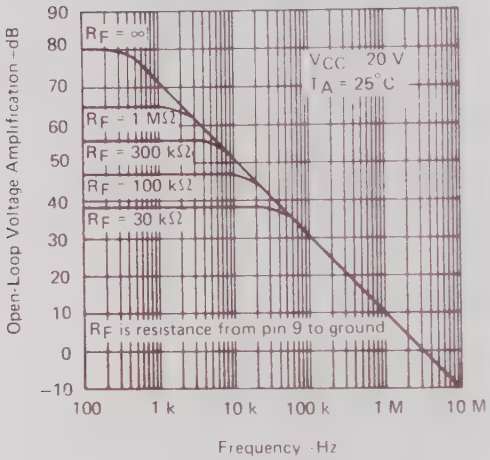

FIGURE 3

OSCILLATOR FREQUENCY
vs
TIMING RESISTANCE

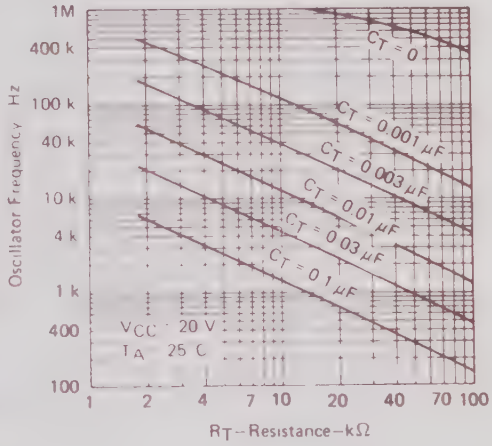

FIGURE 4

OUTPUT DEAD TIME
vs
TIMING CAPACITANCE VALUE

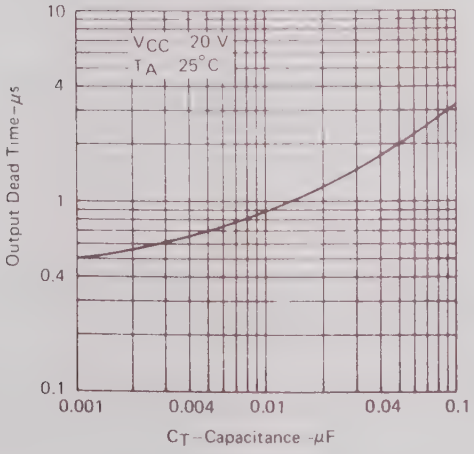

FIGURE 5

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Figure 4.4. Pulse Width Modulator SG3524, Data Sheets (Sheet 5 of 8)

TYPES SG1524, SG2524, SG3524
REGULATING PULSE WIDTH MODULATORS

PRINCIPLES OF OPERATION

The SG1524† is a fixed-frequency pulse-width-modulation voltage-regulator control circuit. The regulator operates at a fixed frequency that is programmed by one timing resistor R_T and one timing capacitor C_T. R_T establishes a constant charging current for C_T. This results in a linear voltage ramp at C_T, which is fed to the comparator providing linear control of the output pulse width by the error amplifier. The SG1524 contains an on-board 5-volt regulator that serves as a reference as well as supplying the SG1524's internal regulator control circuitry. The internal reference voltage is divided externally by a resistor ladder network to provide a reference within the common-mode range of the error amplifier as shown in Figure 6, or an external reference may be used. The output is sensed by a second resistor divider network and the error signal is amplified. This voltage is then compared to the linear voltage ramp at C_T. The resulting modulated pulse out of the high-gain comparator is then steered to the appropriate output pass transistor (Q1 or Q2) by the pulse-steering flip-flop, which is synchronously toggled by the oscillator output. The oscillator output pulse also serves as a blanking pulse to assure both outputs are never on simultaneously during the transition times. The width of the blanking pulse is controlled by the value of C_T. The outputs may be applied in a push-pull configuration in which their frequency is half that of the base oscillator, or paralleled for single-ended applications in which the frequency is equal to that of the oscillator. The output of the error amplifier shares a common input to the comparator with the current-limiting and shut-down circuitry and can be overridden by signals from either of these inputs. This common point is also available externally and may be employed to control the gain of, or to compensate, the error amplifier, or to provide additional control to the regulator.

TYPICAL APPLICATION DATA

oscillator

The oscillator controls the frequency of the SG1524 and is programmed by R_T and C_T as shown in Figure 4.

$$f \approx \frac{1.15}{R_T C_T}$$

where R_T is in kilohms
C_T is in microfarads
f is in kilohertz

Practical values of C_T fall between 0.001 and 0.1 microfarad. Practical values of R_T fall between 1.8 and 100 kilohms. This results in a frequency range typically from 140 hertz to 500 kilohertz.

blanking

The output pulse of the oscillator is used as a blanking pulse at the output. This pulse width is controlled by the value of C_T as shown in Figure 5. If small values of C_T are required, the oscillator output pulse width may still be maintained by applying a shunt capacitance from pin 3 to ground.

synchronous operation

When an external clock is desired, a clock pulse of approximately 3 volts can be applied directly to the oscillator output terminal. The impedance to ground at this point is approximately 2 kilohms. In this configuration R_T C_T must be selected for a clock period slightly greater than that of the external clock.

If two or more SG1524 regulators are to be operated synchronously, all oscillator output terminals should be tied together. The oscillator programmed for the minimum clock period will be the master from which all the other SG1524's operate. In this application, the C_T R_T values of the slaved regulators must be set for a period approximately 10% longer than that of the master regulator. In addition, C_T (master) = 2 C_T (slave) to ensure that the master output pulse, which occurs first, has a wider pulse width and will subsequently reset the slave regulators.

† Throughout these discussions, references to SG1524 apply also to SG2524 and SG3524

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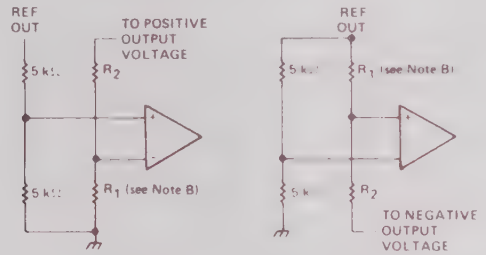
Figure 4.4. Pulse Width Modulator SG3524, Data Sheets (Sheet 6 of 8)

TYPICAL APPLICATION DATA

voltage reference

The 5-volt internal reference may be employed by use of an external resistor divider network to establish a reference within the error amplifiers common-mode voltage range (1.8 to 3.4 volts) as shown in Figure 6, or an external reference may be applied directly to the error amplifier. For operation from a fixed 5-volt supply, the internal reference may be bypassed by applying the input voltage to both the V_{CC} and V_{REF} terminals. In this configuration, however, the input voltage is limited to a maximum of 6 volts



$$V_O \quad 2.5\ V\frac{R1 + R2}{R1} \qquad \frac{R1\,R2}{R1 + R2} \quad 2.5\ k\Omega$$

FIGURE 6–ERROR AMPLIFIER BIAS CIRCUITS

error amplifier

The error amplifier is a differential-input transconductance amplifier. The output is available for dc gain control or ac phase compensation. The compensation node (pin 9) is a high-impedance node (R_L = 5 megohms). The gain of the amplifier is $A_V = (0.002\ \Omega^{-1})\ R_L$ and can easily be reduced from a nominal 10,000 by an external shunt resistance from pin 9 to ground. Refer to Figure 3 for data.

compensation

Pin 9, as discussed above, is made available for compensation. Since most output filters will introduce one or more additional poles at frequencies below 200 hertz, which is the pole of the uncompensated amplifier, introduction of a zero to cancel one of the output filter poles is desirable. This can best be accomplished with a series RC circuit from pin 9 to ground in the range of 50 kilohms and 0.001 microfarads. Other frequencies can be canceled by use of the formula $f \approx 1/RC$.

shut down circuitry

Pin 9 can also be employed to introduce external control of the SG1524. Any circuit that can sink 200 microamperes can pull the compensation terminal to ground and thus disable the SG1524.

In addition to constant-current limiting, pins 4 and 5 may also be used in transformer-coupled circuits to sense primary current and shorten an output pulse should transformer saturation occur. Pin 5 may also be grounded to convert pin 4 into an additional shutdown terminal.

Figure 4.4. Pulse Width Modulator SG3524, Data Sheets (Sheet 7 of 8)

TYPES SG1524, SG2524, SG3524
REGULATING PULSE WIDTH MODULATORS

TYPICAL APPLICATION DATA

current limiting

A current-limiting sense amplifier is provided in the SG1524. The current-limiting sense amplifier exhibits a threshold of 200 millivolts and must be applied in the ground line since the voltage range of the inputs is limited to +1 volt to −0.7 volt. Caution should be taken to ensure the −0.7-volt limit is not exceeded by either input, otherwise damage to the device may result.

Fold back current limiting can be provided with the network shown in Figure 7. The current-limit schematic is shown in Figure 8

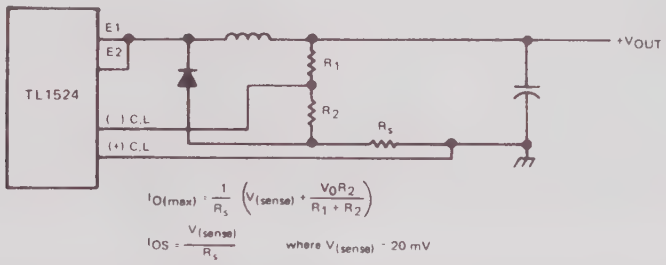


FIGURE 7–FOLDBACK CURRENT LIMITING FOR SHORTED OUTPUT CONDITIONS

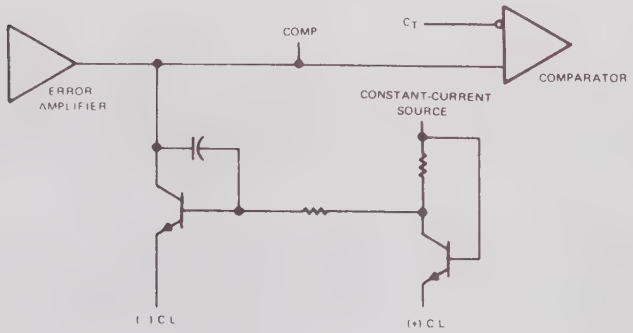


FIGURE 8–CURRENT-LIMIT SCHEMATIC

output circuitry

The SG1524 contains two identical n-p-n transistors the collectors and emitters of which are uncommitted. Each transistor has antisaturation circuitry that limits the current through that transistor to a maximum of 100 milliamperes for fast response.

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Figure 4.4. Pulse Width Modulator SG3524, Data Sheets (Sheet 8 of 8)

Components C10 and R14 set the PWM operating frequency at 40 kHz. Since the push-pull outputs of the PWM (U1, pins 11 and 14) are connected, the drive signal into the gate of transistor Q6 will also be 40 kHz. This driving signal can be monitored at test point TP3. Capacitor C11, connected to the PWM oscillator output (U1, pin 3), sets the minimum "Dead Time" to be greater than 0.5 microseconds. Resistor R13 biases the Shutdown Input (U1, pin 10) to a level where this function has no effect on the PWM operation. Components L1 and C8 filter the feedback signal applied to the Current Limit Sense (+C.L. Sense at U1, pin 4). If the Current Limit voltage developed across resistor R18 permits the voltage at -C.L. Sense (U1, pin 5) to exceed the voltage at +C.L. Sense (U1, pin 4), the PWM will not widen the pulse width to permit an increase in output current.

The collectors of the PWM output transistors are connected to the V_{CC} input source and the emitters are connected to drive the switching power transistor, Q6. Components R15, Q5, and CR9 increase the drive capability by providing rapid discharge of Q6 Gate capacitance. This effects a rapid turn-off as well as turn-on. The switching power transistor, Q6, is a FET device that is OFF (or open circuit) when V_{GS} equals 0V dc and ON (or closed circuit with 0.25 ohm max) when V_{GS} equals 10V dc. Diode CR10 protects Q6 from reverse voltage while network components L2, CR11, and R19 reduce ringing and overvoltage transients on the Drain of Q6. The final -12V dc output is filtered by components L3, C17, L4, and C28 with diode CR12 providing a current path for the inductors when transistor Q6 is switched OFF.

Feedback control and frequency compensation for the PWM is made from a -12V dc source regulated by component U2 through transistor Q7 which provides level shifting. Variable resistor R23 is adjusted to produce the -12V dc output with components C16, R21, C18, R28, C9, and R12 providing frequency compensation. Components CR14 and R26 provide bias voltage for the "plus" input of component U2.

The separate -12V dc source to operate the fan is additionally filtered by components R20 and C15 to isolate the dc fan from the PWM. Diode CR23, transistor Q10, and connecting components provide an overvoltage protection

"crowbar" circuit. When the output voltage exceeds approximately 15V dc, transistor Q10 is switched ON and triggers the SCR diode CR13 to short the -V input and blow the appropriate input fuse. Resistor R25 is rated at 100 ohms, 3 Watts, and is provided to load the -12V dc supply when normal loads are removed. This is necessary because this switching power supply cannot operate into a zero load condition. Some loading must exist for the circuit to remain in regulation.

-5.2 DC Switching Regulator. In principle, the -5.2V dc switching regulator circuit operates identically to the -12V dc switching regulator circuit. There are several circuit changes to accomodate the different voltage range. The first difference to be noted is that the PWM U3 operates between the regulated -12V dc supply and ground rather than the floating supply used with PWM U1. The schematic (Figure 7.23) shows PWM U3, pin 15, is grounded and U3, pin 8, connects to the regulated -12V dc source. The operating frequency used by PWM U3 is set for 65 kHz, which drives the Gate of transistor Q9. This driving frequency can be monitored at test point TP3. The frequency is higher to simplify the necessary filtering for the -5.2V dc output, which can exceed 3.0 amperes when required.

The feedback component U4 drives transistor Q12 as a current source configuration into the PWM U3. Note that the PWM internal amplifiers are not used and the feedback signal is applied instead to the compensation input of the PWM. An overvoltage detector circuit using diode CR24, transistor Q11, and connected components is set to trigger at approximately 7 volts dc. This trigger signal also operates SCR diode CR13 to short the -V input and blow the appropriate input fuse if an overvoltage condition exists. Resistor R50, rated at 50 ohms, 3 watts, loads the -5.2V dc supply when other loads are removed. This supply also requires some load to remain in regulation.

C. +5.0V/+12.0V DC Power Supply Printed Circuit Board Assembly

A block diagram of the +5.0V/+12.0V DC Power Supply PCB is shown in Figure 4.5. This power supply assembly operates similar to the -5.2V/-12V DC Power Supply circuits. The major difference is the negative supply chops the

-22V to -60V applied voltage into regulated sources, while this supply requires a transformer to generate positive output voltages from the negative voltage input. The +12V supply PWM operates from the same voltage source as the -12V supply PWM, but the +12V supply output signals drive a differential transformer. The +5V supply PWM operates from the regulated +12V dc output and does not require a transformer.

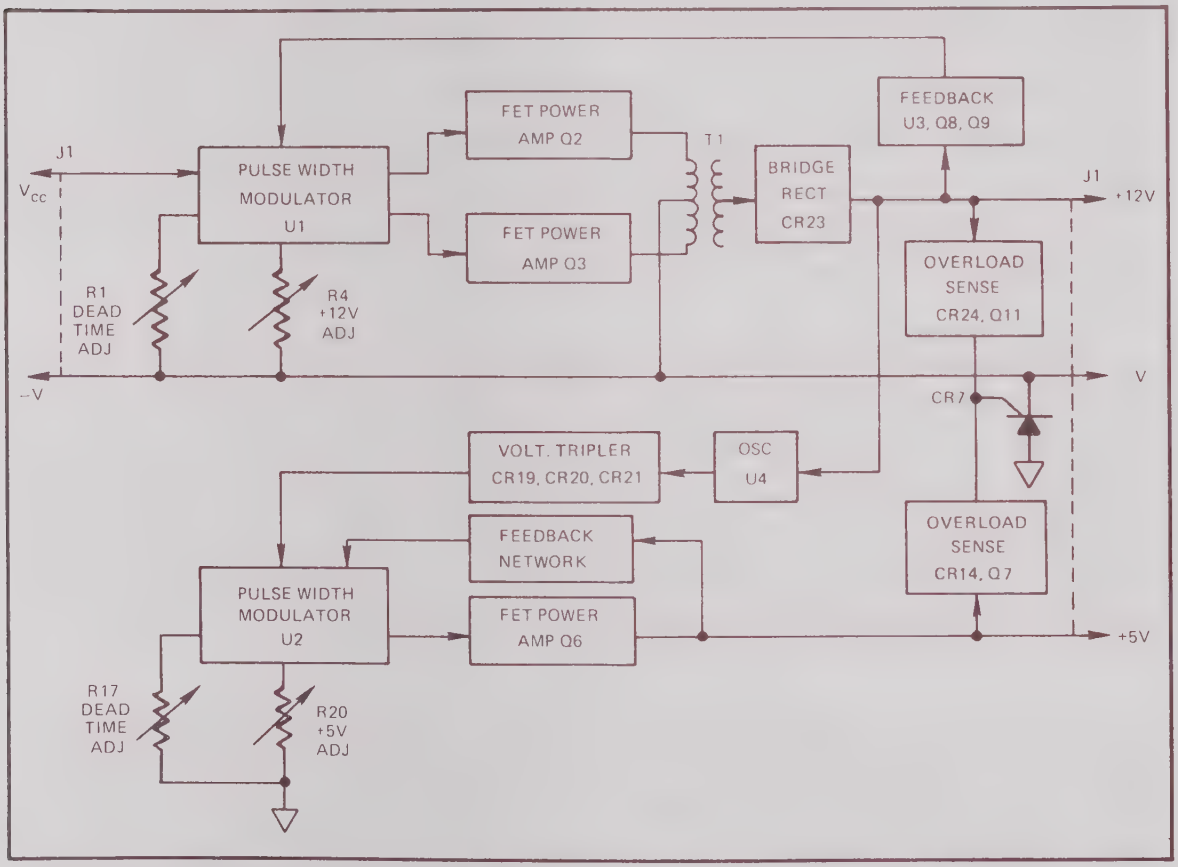


Figure 4.5. The +5.0V/+12.0V DC Power Supply PCB Assembly, Block Diagram

+12V DC Switching Regulator. The schematic diagram for the +5.0V/+12.0V DC Power Supply PCB Assembly is shown in Figure 7.25. When the +5.0V/+12.0V DC Power Supply PCB Assembly is used, it is interconnected with the -5.2V/-12.0V DC Power Supply PCB Assembly through Cable Asembly 220947 which make the functions "-V", "V_{CC}", and GND" common to both supply assemblies. The +12V dc PWM, U1, uses the common functions to operate very similar to the -12V

dc switching regulator. Components C5 and R9 set the operating frequency to 40 kHz, and capacitor C6 maintains a minimum "Dead Time" at not less than 0.5 microseconds. Current limiting, "Dead Time Adjust" (through variable resistor R1), and the power-up delay functions are also similar to the -5.2V/-12.0V DC Power Supply PC Assembly.

Although the +12.0V dc supply is very similar to the -12V dc supply, the output signals from the +12V PWM drive FET Power Amplifiers Q2 and Q3 which, in turn, drive transformer T1 in a differential push-pull arrangement. The Gates of FET Power Amplifiers are driven through transistors Q1 and Q4 to improve the Gate drive signal rise and fall times. Capacitor C7 filters the dc voltage input to the transformer, and components C8 and R14 load the transformer coil to reduce switching transients. The transformer secondary voltage diode bridge CR23 and the bridge output is filtered by components L4 and C28 to become the regulated +12.0V dc output voltage.

Resistors R39 and R40 divide voltage from the +12.0V dc output to establish a midrange input signal level for component U3. This input signal is amplified and then level shifted through transistors Q8 and Q9 to provide feedback voltage into the +12V dc PWM at VIN(-), pin 1. The feedback voltage controls the duty cycle of the FET Power Amplifier "Gate drive" signal to regulate the resulting +12V dc rectified signal. The VIN(+), pin 2, connects to variable resistor R4 which adjusts the final output voltage.

The circuit using transistor Q11, diode CR24, and associated components provide overvoltage protection. If the output level exceeds approximately +15 volts, the overvoltage protection circuit operates SCR diode CR7 until the input fuse blows. Resistor R43, rated at 100 ohms, 3 watts, loads the +12V dc supply when other loads are removed. This supply requires some loading to maintain regulation.

+5V DC Switching Regulator. The +5V dc PWM derives operating power from the regulated +12V dc output. The +12V is applied to component U4 which operates as an oscillator, and the output frequency is rectified by a voltage tripler, CR19, CR20, and CR21. Voltage at the junction of diode CR19 and ca-

pacitor C8 is approximately +25V dc, which is applied to the +5V PWM. The higher voltage is required to adequately raise the FET Power Amplifier "Gate drive" signal. The FET Power Amplifier Q6 is also connected to the regulated +12V dc source, and the Gate drive signal must be raised 10 volts higher to fully switch the FET Power Amplifier into the ON state.

Components C12 and R23 set the +5V PWM to operate at approximately 65 kHz, and capacitor C13 provides a minimum "Dead Time" in excess of 0.5 microseconds. Variable resistor R17 (DEAD TIME ADJ) will establish the maximum duty cycle of the output drive pulses. It is properly set when the +5V dc supply output, operating into a full load with minimum dc input of -22V dc, starts to drop out of regulation as R17 is adjusted clockwise. At this point, the adjustment is given two turns counterclockwise. Proper "Dead Time Adjustment" provides the maximum output current by setting the maximum duty cycle.

Components R18 and C9 provide a power-up delay to prevent PWM U2 from trying to regulate until the applied power source voltage has stabilized. The PWM output drive transistor emitters are connected and drive the FET Power Amplifier, Q6, Gate through components Q5, R24, CR10, and CR11. The signal, monitored at test point TP4, is a 0 to 25V pulse at 65 kHz. The FET Power Amplifier chops the +12V dc at 65 kHz into the regulated +5V dc with filtering provided by components L2 and C15. Diode CR13 provides a conduction path for current in L2 when the FET Power Amplifier (Q6) is switched OFF.

A feedback sense voltage is filtered by components C14, R25, and R22 and returned to the "-V" input of the PWM (U2, pin 1) to control the output voltage. Additional frequency compensation is provided through capacitor C10 connected at the PWM (U2, pin 9) Compensation input. Current limit sensing is not used directly on the +5V PWM (U2) because inputs to the +12V PWM (U1, pins 4 and 5) are grounded. In this circuit arrangement, current limit is better provided through the proper setting of "Dead Time Adjust" variable resistor R17. Components Q7 and CR14 provide an overvoltage sense circuit that operates at approximately +7V dc to enable SCR diode CR7 to shut down the source supply if overvoltage occurs.

Power Fail Sense Circuit. Components R37, C17, CR17, CR18, Q10, and R31 are used as a circuit that senses when the source input voltage varies from the -22V dc minimum toward ground or 0V potential. This circuit provides a signal that will cause isolation of the Real-Time Clock and non-volatile RAM. The Real-Time Clock and non-volatile RAM have an internal battery back up system for operating power during isolation. In addition, the Real-Time Clock and non-volatile RAM are isolated from the microcomputer bus which might otherwise inadvertently change the clock setting or RAM contents during a power down.

If the applied source voltage is between -22V dc and -60V dc, all the current (approximately 1.5 mA) from Constant Current Diode CR17 flows through resitor R37 pulling the base of transistor Q10 below ground, clamped to -0.7V dc by diode CR18, and Q10 is switched OFF. If the "-V" input rises from -60V dc toward ground (or power fail condition), at approximately -19.95V (CR17 at 1.5 mA times R37 at 13.3K), resistor R37 can no longer take all the current from CR17 and current flows into the base of transistor Q10. As the "-V" input rises nearer to ground potential, Q10 will eventually switch ON and pull the Power Fail to ground to isolate the Real-Time Clock and non-volatile RAM. Capacitor C17 provides a stored charge which is discharged through transistor Q10 as the "-V" input rises. This circuit action anticipates the "Power Fail" condition by at least 5 milliseconds.

4.3 MODEL 4657 ANALYZER CIRCUITS

The Model 4657 Analyzer consists of the following major assemblies and printed circuit boards:

Assemblies:

1. Rear panel and power wiring
2. -5.2V/-12.0V DC Power Supply (A12)
3. +5.0V/+12.0V DC Power Supply (A13)
4. Front panel assembly (A14)

Printed Circuit Boards:

1. 44.7 MHz Clock Recovery (A1)
2. B3ZS Decoder and Blue Signal Detector (A2)
3. F-Frame Synchronizer (A3)
4. M-Frame Synchronizer (A4)

5. Pseudo Random Bit Sequence Generator (A5)
6. Error Counter 1/External Event Monitor (A6)
7. Error Counter 2 & 3 (A7)
8. 8080 Processor (CPU) (A10)
9. Real-Time Clock (A9)

The Model 4657 Analyzer may contain one of the following optional printed circuit boards in location A8:

1. RS-232C Input/Output PCB
2. IEEE-488 Bus Interface PCB

The rear panel, power wiring, and dc power supply printed circuit boards have been described in Section 4.2. The Front Panel Assembly consists of four printed circuit boards which will be described separately from the removable printed circuit boards used in the card cage assembly. Major functions used in the Model 4657 Analyzer are shown in the block diagram of Figure 4.6.

A. Front Panel Assembly (A14)

The front panel assembly uses four printed circuit boards which, when interconnected, provide all necessary front panel functions. The four printed circuit boards are: (1) Front Panel Interface PCB (A14A3); (2) Front Panel PCB (A14A4); (3) Clock Display PCB (A14A1); and (4) Error Display PCB (A14A2). Circuit descriptions of these PCB assemblies are provided in the same order.

1. Front Panel Interface PCB (A14A3)

The schematic diagram of the Front Panel Interface PCB assembly is shown in Figure 7.30. Component U1 (an 8279 IC) provides a programmable keyboard/display interface circuit. It contains sixteen 8-bit memories for driving digital displays, the keyboard scanning logic, switch contact debouncing logic, programmable operating modes, and interrupt on key entry circuit functions. It is also compatible with functions of the 8080 microprocessor and, in this application, interfaces directly to the analyzer microcomputer data bus through a flat cable from connector J1 to the Motherboard (A11). The Read

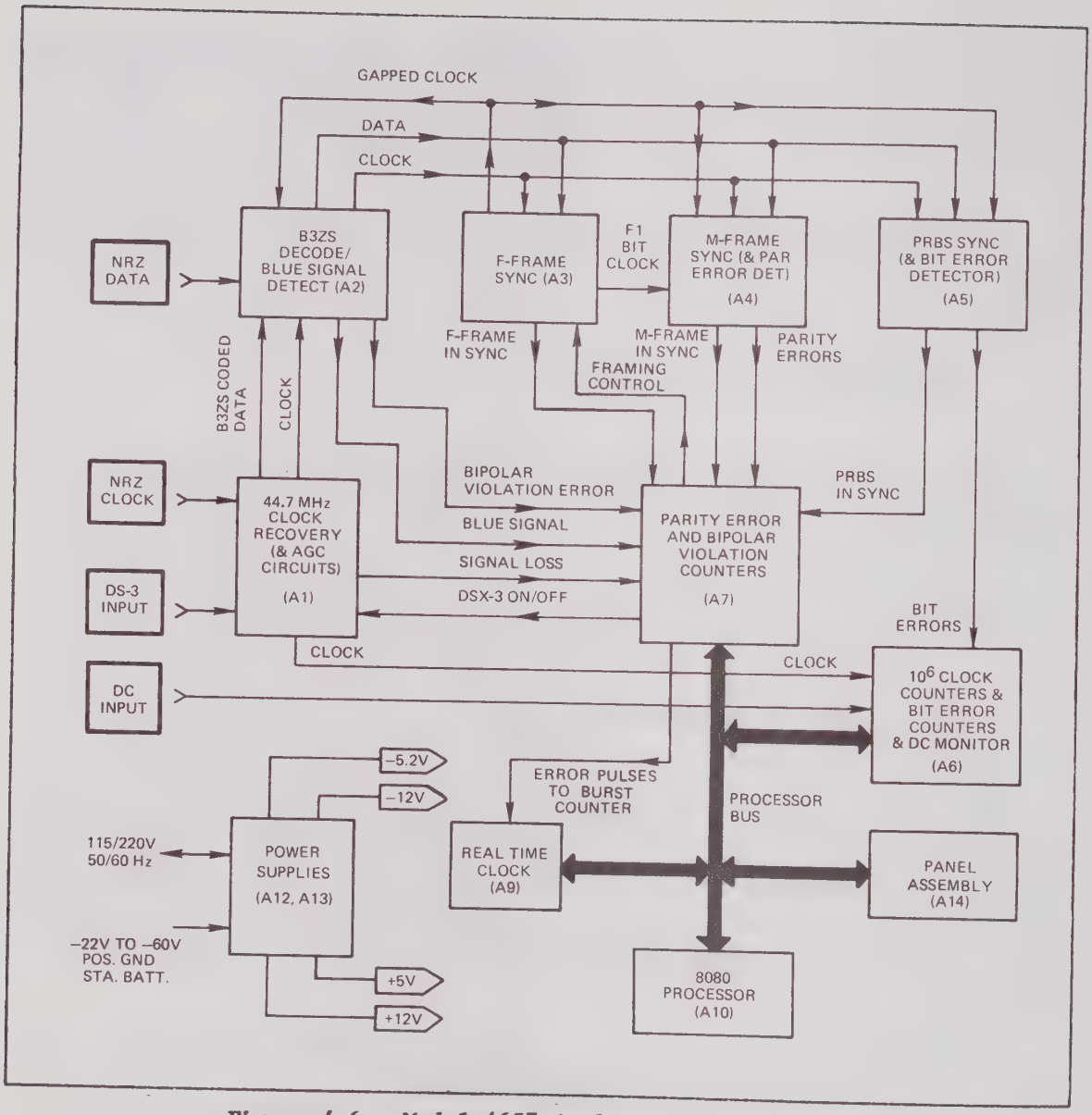


Figure 4.6. Model 4657 Analyzer, Block Diagram

($\overline{RD}$), Write ($\overline{WR}$), Clock, Data Bus (DBØ-DB7), Interrupt, and Address line functions are supplied by the 8080 Processor PCB (A10) and are described in that section.

Component U2 decodes I/O addresses 7ØH and 71H. The resulting output enables U1, through the $\overline{CS}$ input, to respond to these addresses. Note that the

schematic shows switch, display, and indicator connections to the right of U1 for easy reference. The functions RLØ-RL7 are the Return Line inputs from the Switch Scan. The functions SLØ-SL3 are Scan Lines which simultaneously scan the front panel switch array and the displays. Component U4 decodes three of the Scan Lines into a 3-line code which is applied to a switch matrix of U5 and U6. All of the four Scan Lines are decoded by U5 and U6 and the outputs become Display Digit Enable signals.

The functions AØ-A3 and BØ-B3 are outputs from the 16-byte long by 8-bit wide internal RAM of U1. These RAM outputs are synchronized to Scan Line codes so that data location Ø corresponds to Scan Line code equal to Ø, etc. Component U3 buffers the display drivers to provide increased current for the display segment current source drivers on the Front Panel PCB (A14A4). Since the seven segment displays (plus one line for the decimal point) connect directly to U1, all necessary BCD-to-7-segment decoding is done in software. The discrete LED indicators used on the front panel are organized into groups of eight and are driven in a similar fashion. Transistor Q2 and diodes CR1 through CR8 provide bias reference voltages for the current source drive transistors. Since there are more discrete LEDs than there are biases available in the 8279's internal RAM, two separate octal latches (U16 and U17) are used to gain the required capacity.

2. Front Panel PCB (A14A4)

The schematic diagram of the Front Panel PCB assembly is shown in Figure 7.32. Note that the switches are interconnected in a matrix arrangement and also connect to the Scan Lines and Return Lines from the Front Panel Interface PCB (A14A3). The SHIFT switch (S20) is provided a separate interface line so it can perform a SHIFT function for the other switches. Current source transistors, Q1 through Q8, interface with the Current Source Drivers on the Front Panel Interface PCB. Similarly, Digit Enable signals are interfaced with transistors Q9 through Q27 which drive the TIME display segments, the ERROR display segments, the alarm, the colons, and the discrete LED indicators (CR1 through CR37).

3. Clock Display PCB (A14A1)

The schematic diagram of the Clock Display PCB assembly is shown in Figure 7.32. The seven clock digits on this assembly are used to provide the front panel TIME display. All digits are standard seven-segment-plus-decimal-point with a common cathode. The segment and decimal anodes are interfaced with the current source transistors and the cathodes interface with the digit drive transistors provided on the Front Panel PCB assembly (A14A4). Two LED indicators, U8 and U9, are illuminated simultaneously to back light the colons provided for the TIME display.

4. Error Display PCB (A14A2)

The schematic diagram for the Error Display PCB assembly is shown in Figure 7.32. The six seven-segment-plus-decimal-point displays which make the front panel ERROR display are driven similar to the TIME display components.

B. 44.7 MHz Clock Recovery PCB (A1)

A block diagram of the 44.7 MHz Clock Recovery PCB is shown in Figure 4.7. The schematic is shown in Figure 7.3. Circuits on this PCB assembly perform two primary functions: (1) provide automatic gain control (AGC) to hold a constant signal level for the data recovery circuits, and (2) extract the 44.736 MHz clock signal to operate other circuits. This PCB assembly also provides a Signal Loss Detector circuit and the DSX-3 Cable Compensator circuit. If the DSX-3 INPUT is front panel selected, relay K1 is energized, and the applied input signal is routed by closed relay contacts into the DSX-3 Compensator circuit. This circuit uses components C1, R1, R2, R3, R4, L1, and L2 arranged in a "bridged-tee" network. The network compensates both signal phase and amplitude roll-off similar to a 450-foot section of Type 728A cable.

When the LO/HI INPUT mode is front panel selected, the applied input signal is sent through normally open relay contacts to the base of transistor Q1. Transistors Q1 and Q2 form a "gain controlled differential amplifier" pair with the gain set by variable resistance diodes CR1, CR2, and CR3. Transistor

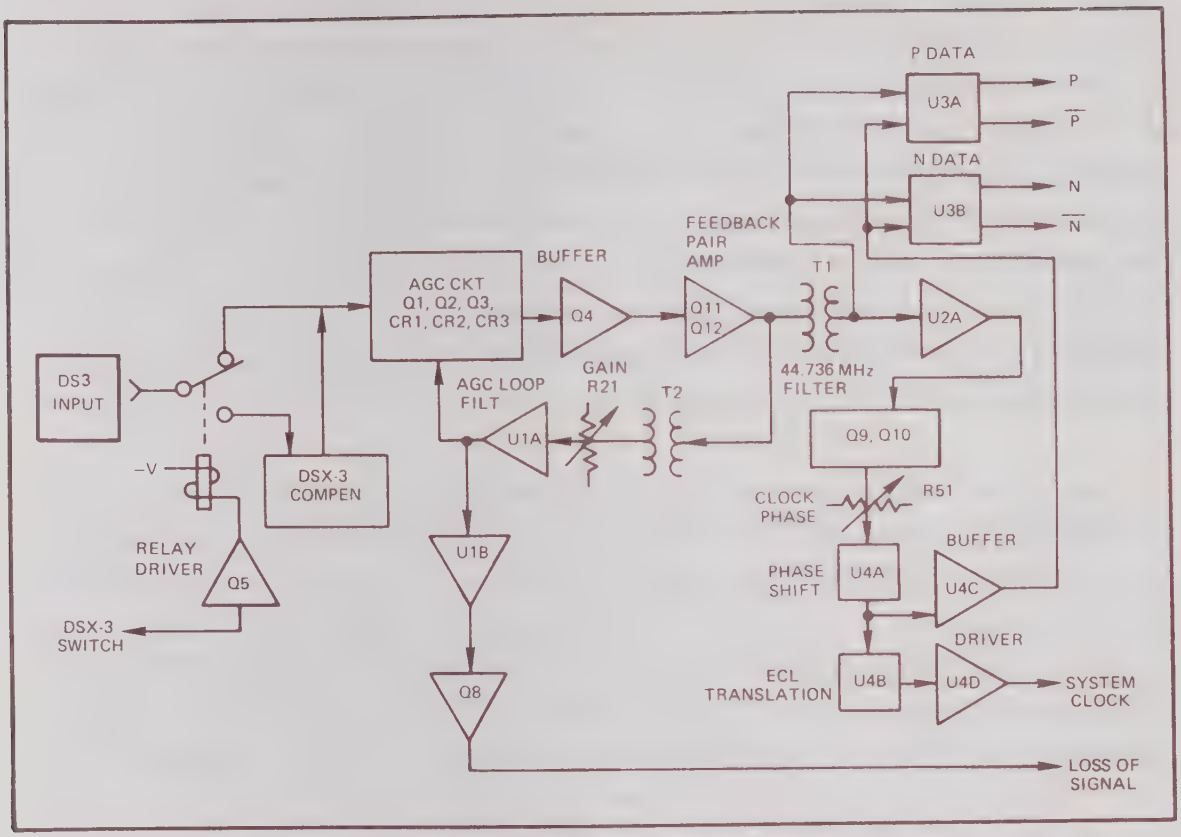


Figure 4.7. Model 4657 Analyzer, 44.7 MHz Clock Recovery PCB (A1), Block Diagram

Q3 controls the current through diodes CR1, CR2, and CR3 which varies the resistance characteristics and thereby controls the circuit gain. Output signals from transistor Q2 are buffered by the emitter follower (Q4) stage before driving feedback pair amplifier transistors Q11, Q12, Q6 and Q7. The gain of Q11 and Q12 is determined by the ratio of resistor R72 value to resistor R68 value, while the gain of Q6 and Q7 is determined by the ratio of resistor R29 value to resistor R31 value. These two stages combined have a total gain of around 33 dB.

The signal output from transistor Q7 is approximately 2-volts peak-to-peak and drives transformers T1 and T2. Secondary signals from transformer T2 drive diodes CR6 and CR7 which peak detect the signal level into a dc level through operational amplifier U1A to close the AGC feedback loop. The dc signal on capacitor C20 is filtered through components L7 and C21 to remove com-

ponents of the 44.736 MHz frequency that may be present. Operational amplifier U1A is provided with capacitive feedback to make it function as an integrator. Output signals of U1A drive transistor Q3 whose current controls the variable resistance diodes and effectively closes the AGC loop. Variable resistor R21 controls the offset applied to the U1A input and therefore adjusts the gain of the loop. Diode CR8 clamps the output of U1A at 0.7 Volt since a large positive voltage would back-bias transistor Q3 and possibly force the differential amplifier out of its linear range. The normal operating range of U1A is approximately 0 Volt to -10 Volts.

Amplifier U1B senses the output changes from U1A. If U1A is positive, the AGC loop is at maximum gain and applied front input signals are below the AGC range. This condition causes U1B, pin 7, to go negative which switches transistor Q8 to OFF and outputs a TTL logic "1", indicating signal loss, to the microprocessor. When input signal levels increase to make AGC operable, U1A, pin 1, becomes negative and U1B, pin 7, becomes positive. This switches transistor Q8 to ON and cancels signal loss indication to the microprocessor.

The secondary winding center tap of transformer T1 is biased at an ECL "0" level (approximately -1.7V dc) by U2, pin 3. This permits a positive logic "1" pulse on the primary winding to produce an ECL logic "1" at U3, pin 7, and U2, pin 4, also an ECL logic "0" at U3, pin 10, and U2, pin 5. A negative logic "1" on the primary produces an ECL logic "1" at U3, pin 10, and U2, pin 5, also an ECL logic "0" at U3, pin 7, and U2, pin 4. The DS3 logic 0 code produces all 0's on the transformer secondary winding. The secondary winding is loaded by resistor R34 to minimize ringing and improve signal rise time.

Both positive and negative ECL "1's", generated by the incoming DS3 input signal, are ORed together by U2A. Output signals at U2A, pin 2, drive transistor Q9 while the recovered logic "1's" are driven through a double tuned 44.736 MHz filter stage made of components L8, C28, C29, C30, C31, C32, and L9 into transistor Q10. The signal at the base of Q10 will be a sine wave because of the filtering. Also, any missing logic "1" intervals will be filled by the tank circuit ringing. This signal is the raw recovered clock signal

which is applied through an adjustable phase shifter of C23 and R51 and then converted into an ECL level square wave at the DS3 rate by U4A. Output signals at U4A, pin 3, clock the dual D flip-flops in U3 (which store the positive and negative "1" pulses) and differentially output them to the B3ZS Decoder logic. The clock signal at U4A, pin 3, is also phase shifted by R55 and C34 into U4B. Output signals at U4, pins 14 and 15, are differentially provided to other PCB's in the analyzer as the System Clock. The fixed phase shift (R55 and C34) align clock and data signals for other circuits; while the adjustable phase shift (R51 and C23) align clock and data signals for the "D flip-flop" circuits.

When an NRZ CLOCK input signal is applied to connector J4, it is capacitor coupled into U5 where it is ORed with the DS3 Recovered Clock (which cannot be used simultaneously with the NRZ Clock). The resulting clock signal is amplified by U4D before distribution to other PCB's. Diode CR9 detects the peaks of the Clock signal and appropriately switches U1B to indicate either Signal (present) or Signal Loss to the analyzer microprocessor. Amplifier U5 is biased so that no input signal produces a logic "0" output at U2-15. Similarly, with no DS3 input signal, the output at U4A, pin 3, is biased to be logic "0".

C. B3ZS Decoder and Blue Signal Detector PCB (A2)

A block diagram of the B3ZS Decoder and Blue Signal Detector PCB is shown in Figure 4.8. The schematic is shown in Figure 7.5. The primary functions of this PCB are: (1) to combine the positive and negative logic "1" pulses into a single unipolar bit stream, (2) to remove "1's" inserted for the 3-zero suppression, and (3) to detect coding or bipolar violation errors. A differential line receiver (U7A, U7B, and U7D) is used to regenerate the differential clock and data stream input signals into single ended ECL levels. The data streams are buffered by U4A (pin 2) and U4C (pin 15) before being NOR'ed together by U6C (pin 14). This U6C output signal is the inverted combined unipolar signal with 3-zero suppression. Components U1A, U1B, and U2A form a three stage shift register. The regenerated clock signal from U7D (pin 14) is used to clock this shift register and other flip-flops in the circuit.

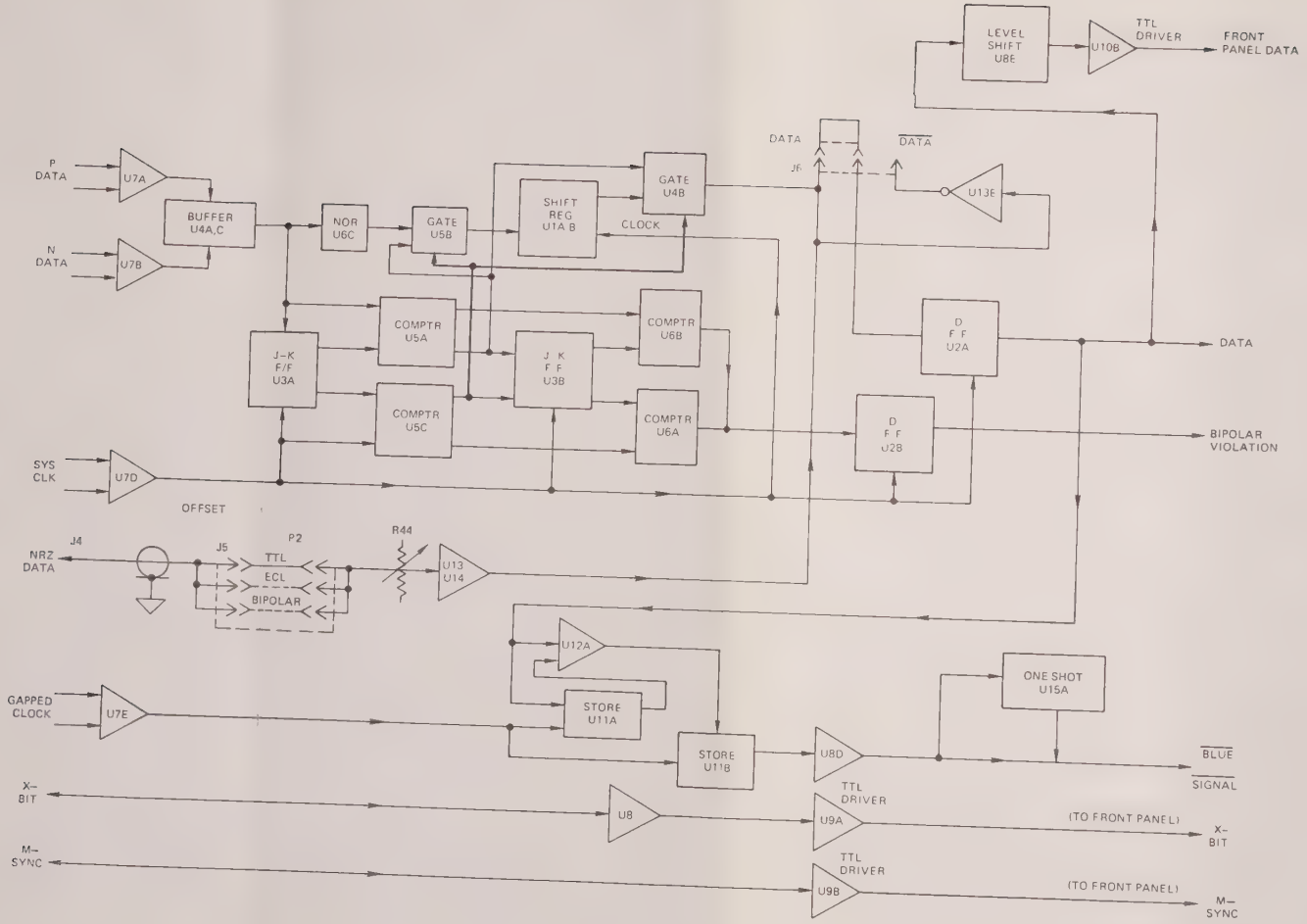


Figure 4.8. Model 4657 Analyzer, B3ZS Decoder and Blue Signal Detector PCB (A2), Block Diagram

The gates, U4B and U5B, are used to suppress zeros when a polarity violation is detected. The flip-flop shown as U3A stores the polarity of the last "1" to enter U1A. This operation requires U3, pin 2, to be a "1" when the signal is a positive "1", and U3, pin 3, to be a "1" when the signal is a negative "1". Comparators U5A and U5C compare the polarity of incoming data with the polarity of the last "1" received. Two successive "1's" of the same polarity will give a logic "1" on the NOR outputs at U5, pin 3, and U5, pin 14, which will force "0's" into U1A and U2A on the next clock pulse which corrects for the suppressed "0's".

Flip-flop U3B stores the polarity of the last violation. Data errors at low error rates cause successive violations of the same polarity. Outputs of comparators U6A and U6B are OR connected and switch to a logic "1" if the last violation is identical to the present violation. A detected bipolar violation from U6A/U6B (pins 2 and 3) is latched into flip-flop U2B on the next clock cycle. Bipolar violation and data are differentially output for counting by circuits on the Error Counter 2 & 3 PCB (A7). This output signal is also applied to Level Shifter U8E where the ECL data is converted to TTL levels and amplified by a 50-ohm driver, U10B, before driving the front panel OUTPUT-DATA connector.

Signals from the front panel INPUT-NRZ-DATA connector are level shifted and buffered by U14A, U13A, and U13B. Using jumper P2 at connector J5 provides internal selection of processing Bipolar, ECL, or TTL data signals. If TTL signal levels are selected, component U14A shifts the TTL to ECL signal levels; or if ECL signal levels are selected, component U13A only buffers the signal. If bipolar signal levels are selected, the +1V/-1V inputs are level shifted by a resistor network into component U13B. The outputs of all the buffers are wire ORed and buffered again by U13D. The U13D output is wire ORed with the DS3 recovered data. If necessary for a particular test arrangement, data may be inverted by moving the jumper at connector J6. The signal is then inverted by U13E but this also inverts bipolar data and will prevent DS3 bipolar data from working correctly.

Additionally, since the data outputs are wire ORed and not selected, it is imperative that all unused buffers have inputs biased to present a "0" output. A "1" output would force all bits to be "1's" and make the analyzer inoperable. For this reason, variable resistor R44 is provided with U13B to set bias on pin 6 to be 300 (±30) mV below pin 7 when BIPOLAR data is selected.

The BLUE Signal is detected by checking for a ...101010... data stream, or a data signal where each new bit is opposite of the last bit. Component U11A is used to store the last data bit so U12A can compare the last data bit with the new data bit. The output at U12, pin 3, is a "1" when the compared bits are different and the comparison result is stored in U11B. Both U11A and U11B are timed on the Gapped Clock signal, which is missing a clock pulse during the framing bit interval, so the BLUE Signal test will be done on data bits and exclude the framing bits. The output signal is applied to component U8D which converts the ECL level to TTL level. The circuit is arranged so the output (U8, pin 12) will be a logic "0" where successive bits are opposite and a logic "1" when they are the same. An output logic "1" will trigger the One-Shot circuit of U15A and force the output (U15, pin 13) to a logic "1". Diodes CR1 and CR2 will OR the signals of U8, pin 12, and U15, pin 13, so if either is a logic "1", the BLUE Signal will not be indicated. If U8, pin 12, remains a logic "0" and the U15A circuit times out, the PCB output line is switched low causing a BLUE Signal indication.

The X-BIT signal is converted by U8B from ECL data to TTL levels. Component U9A is a TTL 50-ohm driver whose output is provided to the front panel OUTPUT - X-BIT connector. Similarly, component U9B drives the front panel OUTPUT - M-SYNC connector with M-Frame (or superframe clock) reference signals.

D. F-Frame Synchronizer PCB (A3)

A block diagram of the F-Frame synchronizer PCB is shown in Figure 4.9. The schematic is shown in Figure 7.7. The F-Frame signal is declared to be "In Sync" when 15 successive input F-bits match with a predicted pattern. The F-Frame signal is declared "Out-of-Sync" when 3-of-15 input F-bits disagree

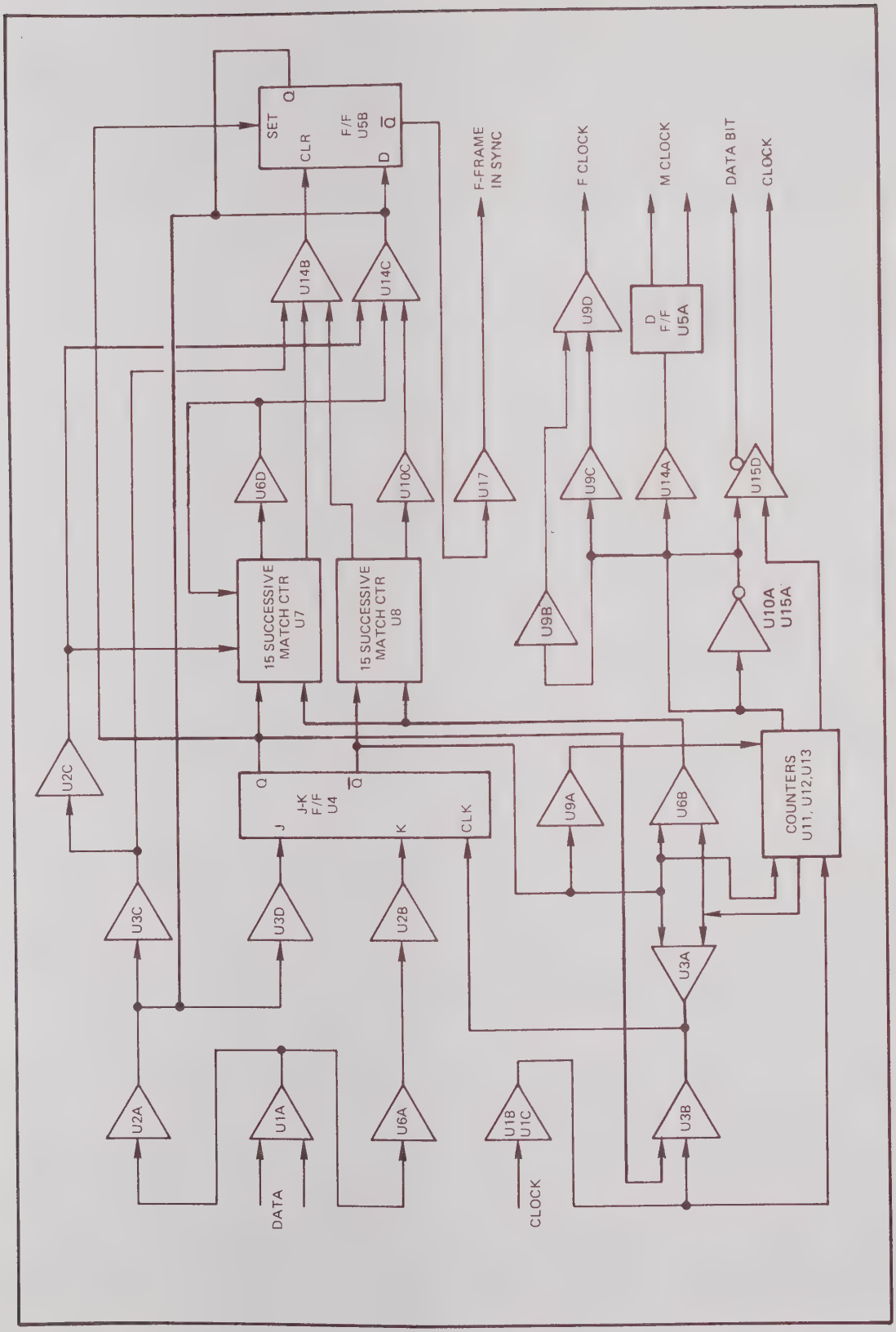


Figure 4.9. Model 4657 Analyzer, F-Frame Synchronizer PCB (A3), Block Diagram

with the predicted pattern. To locate an F-bit in the data stream, a counter is started on the next data "1" presuming it to be the first bit of the ...1100... F-bit pattern. An internal counter also generates its own ...1100... sequence to be compared with the input F-bits. If an error is detected before 15 successive matches, the counters are reset and circuits wait for the next data "1". It is by this trial-and-error method that the F-Frame sequence is found. Once the F-Frame pattern is found in the incoming data, the internal counters can be synchronized and the M-bit clock and the gapped or data clock can be decoded.

The J-K flip-flop, U4, will signal other circuits when a "Data 1" has been found and also if F-bit comparison is in progress. Input data signals are regenerated by U1A and buffered by U6A and U2B into a $\overline{K}$ input at U4, pin 6. The next "Data 1" signal will cause the Q output, U4, pin 2, to switch from high to low. This switched function can be called "Waiting for Data 1 to Compare F-Bit State". While waiting for a "Data 1", the U4Q and $\overline{Q}$ functions will: (1) reset U7 and U8 which are the 15 successive match counters, (2) preset the counter chain of U11, U12, and 13 which generate F-Bits and the F-Bit Clock signals, (3) select the 44.7 MHz System Clock through U3B to time the U4 functions, and (4) force "In-Sync" flip-flop U5 to provide the "Out-of-Sync" signal.

To permit operation with unframed data, a control line is provided by means of which the microprocessor can force U4 to the set state. Thus the framing logic will always be "Waiting for Data 1 to Compare F-Bit State", the clock will never be gapped, and framing will never happen. This control line originates on the "Error Counters 2 & 3" PWB, A7.

After U4 switches to the "Compare F-Bit State", then: (1) counters U7 and U8 are enabled to count F-Bit matches, (2) the counter chain of U11, U12, and U13 are enabled to generate F-Bits and the F-Bit Clock, (3) component U3A selects the F-Bit Clock to time the functions of U4, and (4) the Set line of U5B is released allowing the "In Sync" signal to occur. Counters U11 and U12 divide the System Clock signal by 85. Counter U13 further divides the clock signal to generate the F-Bit Clock signal at U13, pin 3, and the F-Bit Pattern

signal at U13, pin 15. The F-Bit Pattern signal is compared with the incoming data signal by the exclusive OR gate U2A. In the "Out-of-Sync" condition, component U3D passes the resultant comparison to the $\overline{J}$ input of U4 (pin 4). Since U4 is now timed by the F-Bit Clock, U4 will stay in the comparison mode if U2A indicates a match; or U4 will switch back and wait for the next "Data 1" signal if U2A indicates an F-Bit Error.

Once F-Frame Synchronization is achieved, U3D is disabled and U4 is inhibited from switching with an F-Bit Error. Signal comparison has enabled the Master Reset (MR) input to U7 which releases the MR input of U8 and normal counting modes are continued. The Clock Enable (CE) inputs on pin 6 of U7, and U8 goes low to enable U7 and U8 only during an F-Bit interval. The F-Bit interval is gated from the U11, U12, U13 counter chain by component U6B, allowing U7 and U8 to count up for each F-Bit. If an F-Bit mismatch occurs before sync is achieved, U4 will reset U7 and U8 back to zero. When 15 consecutive matches occur, U7 and U8 will reach terminal count and both $\overline{TC}$ outputs (at pin 4) will go low and switch U14B, pin 2, high. This action switches flip-flop U5B high to indicate the "F-Frame In-Sync" condition.

Once F-Frame sync is acquired, U7 and U8 are locked up at terminal count through the two $\overline{PE}$ (at pin 5) inputs until an F-Bit error occurs. The Preset inputs of U7 and U8 (pins 7, 9, 10, and 11) monitor the F-Bit comparison and can only switch to "0" during the F-Bit interval, and only if an F-Bit is in error. Both the F-Bit Interval and the F-Bit Comparison are gated by component U2A and U2C. Thus, with no errors and $\overline{PE}$ enabled, component U7 is continually set to all "1's" (or the terminal count). If an error occurs, U7 is preset to "0" and starts counting back to terminal count with each F-Bit. If another F-Bit error occurs while U7 is counting back, component U8 will be preset to "0" through U10D and it will start counting back to a terminal count. If a third error occurs while U7 and U8 are counting back, this error will be gated through U14C to U5B which will clock to the "Out-of-Sync" condition on the next system clock signal.

Note that U7 will be set to "0's" as U5 switches so that 15 matches will be required before U7 can reach terminal count. If only one or two errors

occur during a 15-bit inteval, U7 and U8 will reach terminal count and hold while waiting for the next error. If a third error occurs after U7 has reached terminal count and U8 is still counting, then U7 will be set to "0" again but "Out-of-Sync" will not be declared. To go "Out-of-Sync" requires at least three errors in a 15 F-Bit interval.

Component U15D gates the system clock with the divide-by-85 output from U11 and U12 to generate the gapped or data clock. Component U14A gates the counter output to decode the M-Bit location. Component U5A resynchronizes the M-Bit with the data clock to provide the differential M-Bit clock at the output (U5A, pins 2 and 3). Components U9B, U9C, and U9D will decode the first F-Bit after the M-Bit. This signal will be used by the M-Frame Synchronizer circuits.

E. M-Frame Synchronizer PCB (A4)

A block diagram of the M-Frame Synchronizer PCB is shown in Figure 4.10. The schematic is shown in Figure 7.9. The M-Frame Synchronizer circuits serve to synchronize the seven M-bits in a superframe and then make a parity error measurement on the data. The seven M-bits (as shown in Figure 4.10) are represented as XXPPØ1Ø. To find this pattern, the M-bits are loaded into a shift register. Then a series of gates decode the pattern and synchronize to a counter which is dividing the M-bit clock by seven. If the counter pulse matches with two successive occurrences of the XXPPØ1Ø pattern, a signal is generated to declare the "M-Frame In-Sync" to the microprocessor.

Once the M-Frame pattern is declared "In-Sync" (if two out of three detected sequences do not agree with the counter), a signal is generated to declare "M-Frame Out-of-Sync". Parity is calculated by toggling a flip-flop with each data "1" and comparing the results with the Parity bits (or the P-bits in the M-Frame sequence) when M1 occurs.

Incoming data is loaded into 4-bit shift registers U1 and U2 using the M-Clock signal as the shift register clock. Component U6B tests for matching X-bits from U2, pins 2 and 15, while U6A tests for matching P-bits from U2,

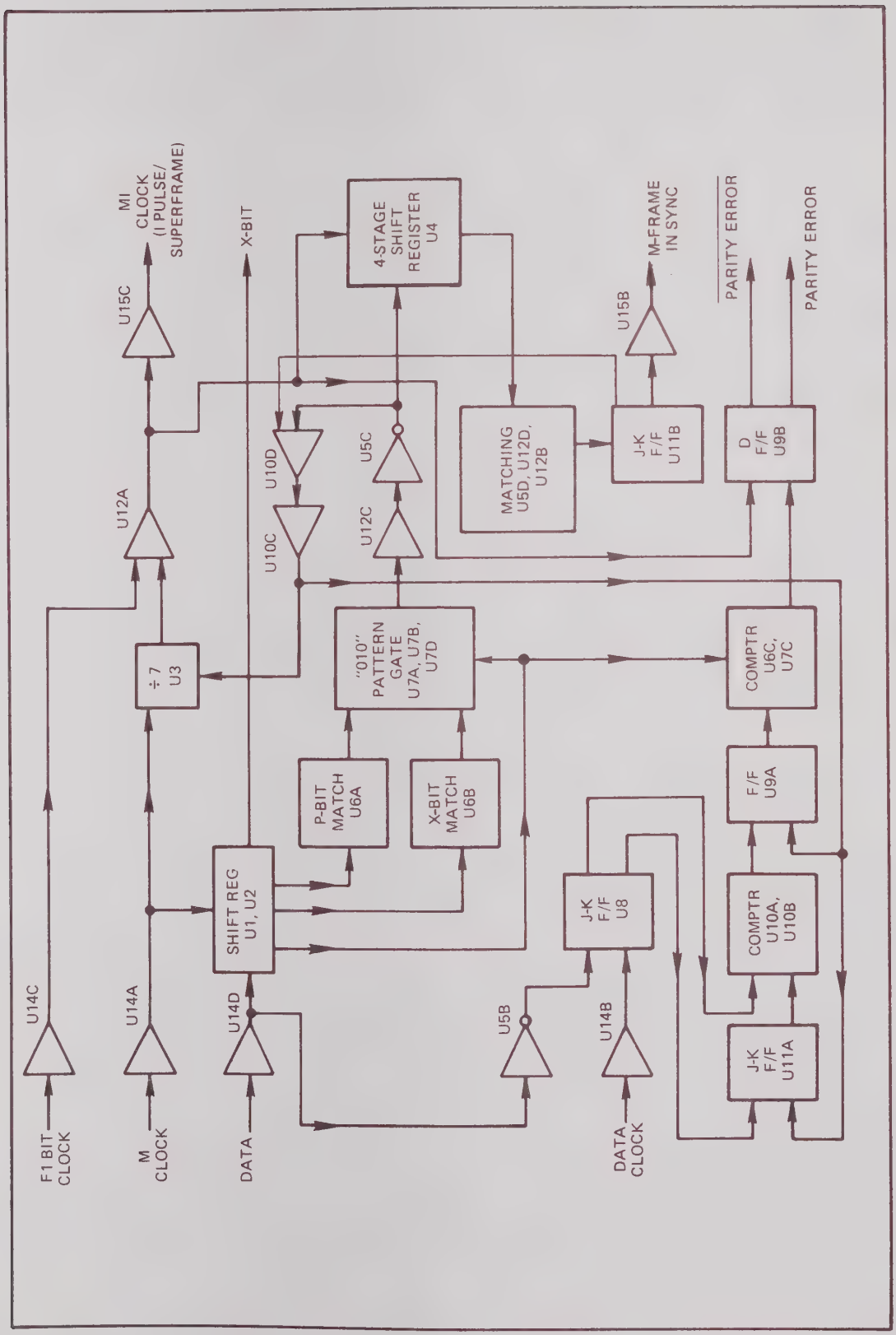


Figure 4.10. Model 4657 Analyzer, M-Frame Synchronizer PCB (A4), Block Diagram

pins 13 and 14. Components U7A, U7B, and U7D gate the "010" pattern to a circuit arrangement where U12C, pin 14, will switch to a logic "1" only if U1, pin 14, is a "0", U1, pin 15, is a "1", and U1, pin 2, is a "0" at the time when signals at U2-1/U2-15 are identical. This condition will be held for one M-bit (or 680 clock cycles).

When the signal comparisons permit U12C, pin 14, to switch to a logic "1", this signal is inverted by U5C and applied as an input to the four-stage shift register, U4. The same logic "1" is also gated with the "Out-of-Sync" line at U10D and gated again by U10C with the terminal count of the Divide-by-Seven Counter (U3). The resulting signal is used to synchronize U3 to the XXPPØ1Ø pattern.

The terminal count signal (U3, pin 4) is also gated through U12A with the incoming F1 Bit Clock signal to clock the shift register U4. When the signal patterns synchronize, the shift register, U4, loads with "0's". Component U5D detects two successive matches and switches flip-flop U11B to indicate "In-Frame" which disables U10D from further synchronizing U3. If two of three bits loaded into U4 are "1's", the out-of-sync pattern is detected by U12D and U12B which will cause U11B to be reset to "Out-of-Sync" condition.

Input data signals are also inverted by U5B and applied to a J-K flip-flop (U8) which toggles with each Data "1" bit. The J-K flip-flop U11A is timed by the M-1 clock and stores the state of U8 from the last parity or superframe cycle. The saved state signal of U11A is exclusively ORed with the U8 output by U10A and U10B. If U10, pins 2 and 3, are a logic "1" at the M-1 clock pulse, then U8 and U11A outputs are in the same state indicating U8 toggled an even number of times since the last M-1 pulse. Conversely, if U10, pins 2 and 3, are a logic "0", then U8 has toggled an odd number of times and U11A must toggle for an odd number of "1's" to equal the same state as U8 at the M-1 clock.

Flip-flop U9A stores the output of U10A and U10B. The state of U9A, pin 3, indicates whether an odd or even number of "1's" was contained in the last superframe. This signal is compared with both parity bits by U6C and U7C and

the resulting signal is input into the D flip-flop, U9B, which is latched to the state of the parity test. The M-1 clock resets U9B so that successive parity bit error will cause separate parity error output pulses from U9B.

F. Pseudo Random Bit Sequence Generator PCB (A5)

A block diagram of the Pseudo Random Bit Generator PCB is shown in Figure 4.11. The schematic is shown in Figure 7.11. Circuits on this PCB generate a 32,767-bit sequence and synchronize it with a matching input sequence. Then a bit-by-bit comparison is performed to make bit error measurements. There is also an auxiliary circuit that determines the out-of-synchronization condition and causes the proper re-load of the sequence generator to resynchronize it to present signal conditions.

Components U3, U4, U5, and U6 are each a four-bit shift register and are cascaded to form a 15-bit shift register (the 16th stage is not used). This shift register is timed by the Gapped (or Data) Clock and the data input is either normal data or feedback data (counter stages 14 and 15; U6, pins 15 and 12) through exclusive OR gate U8B. The circuit synchronizes the internally generated data sequence by loading the shift register with 15 bits of incoming data, then switching the shift register to "feedback" data through U8B. U7A and U7B form a Multiplexer to pick incoming data or feedback data.

The flip-flop component U2A selects between the Run or Load conditions. During the Load Mode, the 16-bit Counter (U1) is enabled to count 15 data clock cycles, while flip-flop U2A directs input data selection be made from the Shift Register through gate U7A. The Counter (U1) reaches terminal count after 15 data bits and resets flip-flop U2A which disables U1 and directs input data selection to the shift Register through U7B (or feedback data). If the incoming data signal was produced by a similar matching sequence generator, the input data will match, bit-for-bit, with the feedback data through U8B.

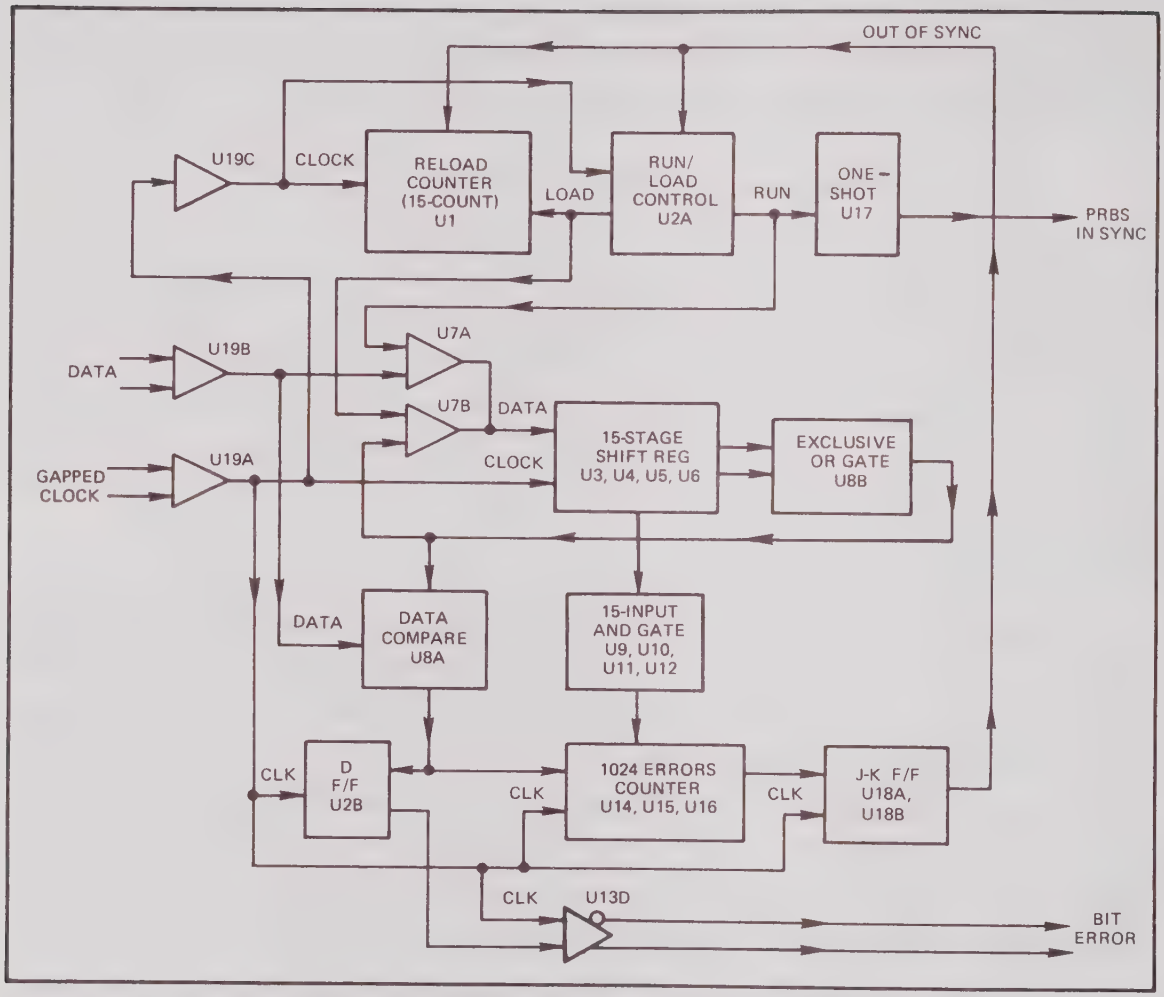


Figure 4.11. Model 4657 Analyzer, Pseudo Random Bit Sequence Generator PCB (A5), Block Diagram

Component U8A also performs a bit-by-bit comparison with the output (U8A, pin 2) being a logic "0" for each mismatch. A mismatch becomes an enable input to the 1024 Error Counter chain (components U14, U15, and U16), and to the input of Bit Error flip-flop U2B. The "Q" output of the Bit Error flip-flop (U2B, pin 15) is internally gated by the Gapped Clock signal to produce an output error pulse for each data bit error. Each data bit error also causes the counter chain to increment. If 1024 errors occur before 32,767 bits are totaled, the counter output (U16, pin 2) switches high. This signal causes flip-flops U18A and U18B to generate a pulse that will: (1) set U2A to the Load Mode, (2) cause the shift register components to re-load, and (3) fire

the One Shot (U17). The One Shot output signal is returned to the analyzer microprocessor circuits. When the incoming data presents compatible pseudo random bit sequences, the U17 output remains low indicating the In-Sync condition. If U17 is triggered, the output goes high and the microprocessor signals the condition by flashing the front panel PRBS FRAME indicator.

Components U9, U10, U11, and U12 are used as a 15-input AND gate that will detect the "ALL 1's" condition of the 15-stage shift register. The "ALL 1's" condition will occur once per 32,767 bits and cause an output pulse from this circuit. This pulse will reset the 1024 Error Counter circuits and require another sequence of 1024 errors per 32,767 bits to reload the shift register.

G. Error Counter 1/External Event Monitor (A6)

A block diagram of the Error Counter 1/External Event Monitor PCB is shown in Figure 4.12. The schematic is shown in Figure 7.13. Since this assembly contains two separate circuits (with only the address decoding being common), this discussion will be divided into two sections.

1. Error Counter 1 Circuit

This circuit accepts Bit Errors, a SIGNAL LOSS line, and the system 44.7 MHz Clock input signals. The outputs are an interrupt signal to the microprocessor every one million (10^6) clock cycles and a Bit Error Total for the microprocessor input.

The 44.7 MHz System Clock is buffered by U1A; and the output (U1A, pin 14) is applied to a Ripple Counter Chain of components U8, U9, U10, and U11. The counter tallies each clock pulse up to 1,000,000 which switches the output (U11, pin 9) high. This output pulse is applied to the Dual "D" flip-flop U7 which is also timed by the system clock through component U13. The output pulse from U7 is the 1.0 megabit strobe which is one clock cycle wide (or 22 nanoseconds). The U7 output pulse is also returned to resynchronize the counter chain because the counters are ripple-through and are not synchronous.

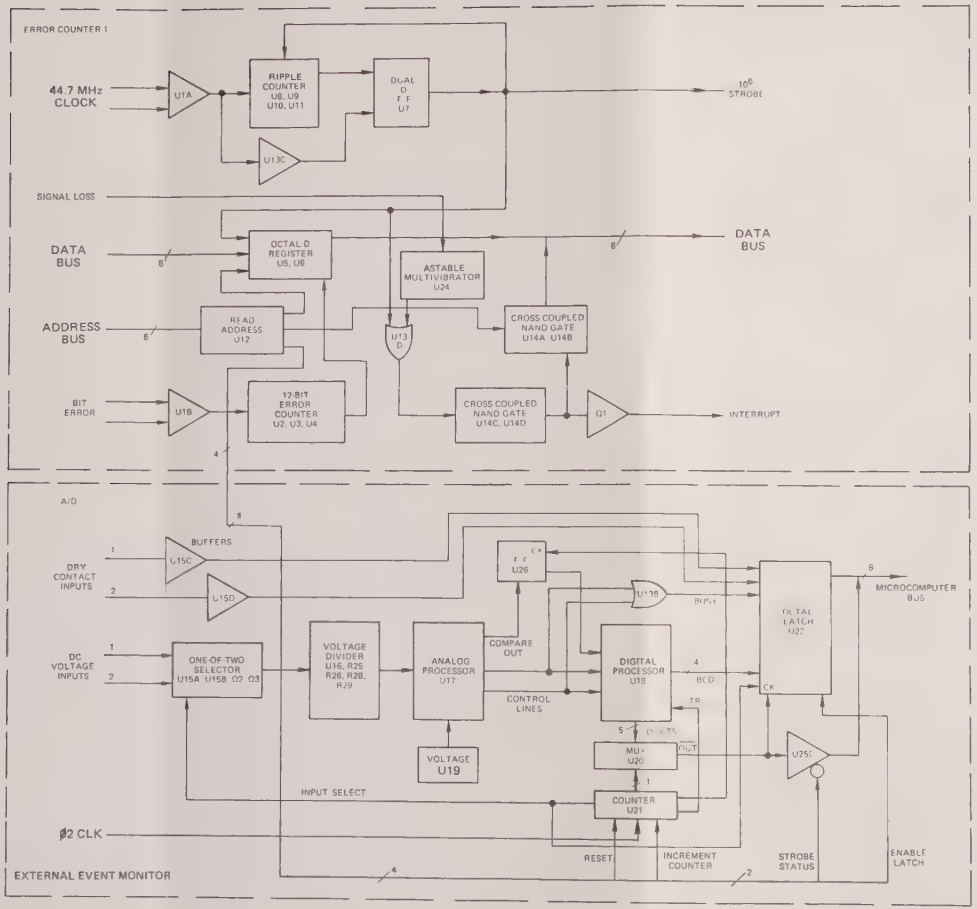


Figure 4.12. Model 4657 Analyzer, Error Counter 1/External Event Monitor PCB (A6), Block Diagram

A third use of the U7 output pulse is to strobe the Octal D Registers (U5 and U6) which input data from the 12 Bit Error Counters (U2, U3, and U4) at a time when the error counters are stabilized.

Components U2, U3, and U4 are used as a synchronous cascade counter. Since it is possible to have successive bit errors, the counter can tally errors at the 44.7 MHz clock rate. Having only a 22 nanosecond wide pulse, strobe timing is critical for U3 and U4 to latch a stable count. But as U3 and U4 are strobed, the flip-flop action of Cross Coupled NAND Gate U14 is set to switch transistor Q1 to ON and generate an Interrupt signal. An Interrupt signal is provided to the microprocessor for every million bits counted. This enables the microprocessor to read accumulated errors per million cycles and perform other error rate calculations.

Component U12 decodes two I/O Addresses from the microprocessor bus. When U12, pin 15, goes low, the address DØH has been decoded enabling the 3-state outputs of Register U5 to put the low order 8 bits of error count on the microprocessor data bus. Similarly, U12, pin 14, goes low when address 21H is decoded, enabling Register U6 to put the four high order error bits on the microprocessor bus. At the proper time during this sequence of error bit read-out, the output of U12 (pin 14) is inverted by U23F to enable U14B to put the Interrupt status bit on the DB4 line. This enables the microprocessor to verify that the million bit interrupt occurred.

During a signal loss condition, U25C is disabled, removing C31 from ground and allowing U24 to function as an astable multivibrator. Also, U23C causes U7B to SET which in turn CLEARS U7A and removes the 10^6 STROBE from the INTERRUPT line and replaces it with the strobe from the 555 (U24). This is done to insure interrupts during a SIGNAL LOSS condition.

2. External Event Monitor Circuits

The External Event Monitor circuit accepts two DC VOLTAGE inputs and two DRY CONTACT inputs. Its output consists of four bits to identify the BCD

(binary coded decimal) value of the selected digit plus four control bits which are put onto the data bus.

The counter (U21A) controls the sequencing of this circuit. Pins 5, 6, and 7 provide a count from 0 to 4 to the multiplexer (U20) thus selecting digits 1 through 5 to be input sequentially by the Digital Processor (U18). When the fifth digit is selected, pin 3 of U21 (INPUT SELECT) toggles. This causes U15A and U15B to turn on either Q2 or Q3. Thus the Digital Processor outputs first the BCD value of digits 1 through 5 for one input and then the other.

The selected input voltage is divided by the ratio of R24 to R25 + R26 (or R28 + R29), and limited by CR1 and CR2 (or CR3 and CR4). U19 provides a stable reference voltage for U17 (nominal 3.00V) by R32. This reference voltage provides U17's internal comparator with a half scale voltage reference point. Counter U21B divides the 2.048 MHz $\emptyset_2$ CPU clock by 5 to produce the 409.6 kHz clock used by the A-D circuitry. Component U26 is arranged to form a D flip-flop clocked by the counter U21B so that the COMP OUT data of U17 will be clocked into the COMP IN input of U18 at the same rate at which the DC INPUTS are selected. The two control lines (A and B), when ORed together by U13B, provide an indication to the microprocessor that U17 and U18 are BUSY. U18 is triggered each time a new digit is selected by U21 pin 7. Therefore, a new four bit BCD value is output to the microprocessor for each of the five digits of each of the two input voltages.

The two dry contact inputs are buffered and converted to TTL levels by U15C and U15D and sent to the microprocessor through latch U22 each time a new BCD value is read.

H. Error Counters 2 & 3 PCB (A7)

A block diagram of the Error Counters 2 & 3 PCB is shown in Figure 4.13. The schematic is shown in Figure 7.15. Circuits on this PCB count both bipolar violation errors and parity errors. A pulse on the 10^6 strobe transfers the error count into respective latches where it can be read by the micropro-

cessor. There is also interface circuitry to allow the microprocessor to read the several status conditions and control the mode of operation of various circuits.

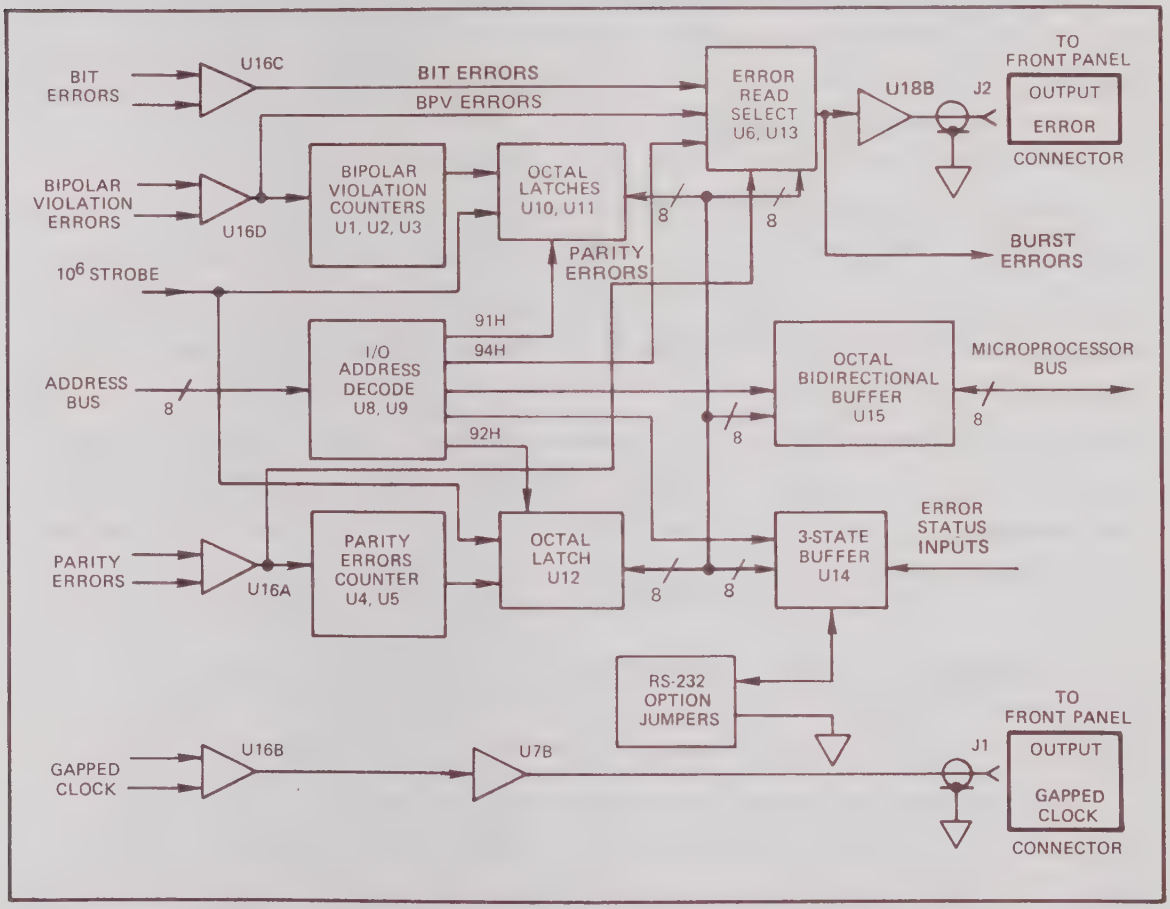


Figure 4.13. Model 4657 Analyzer, Error Counters 2 & 3 PCB (A7), Block Diagram

Cascaded synchronous counters U1, U2, and U3 total the bipolar violation error count being applied through buffer U16D from the B3ZS Decoder and Blue Signal Detector PCB (A2). The counter outputs are connected to octal latches U10 and U11 which latch the counter reading when pulsed by the 10^6 strobe from the Error Counter 1 PCB (A6). When the decoders U8 and U9 read I/O addresses 9ØH and 91H, U8, pins 15 and 14, switch low, respectively. This enables a 3-state output switch circuit internal to U10 and U11 to put the counter reading on the microprocessor data bus through octal buffer U15.

Similarly, counters U4 and U5 total the parity error count being applied through buffer U16A from the M-Frame Synchronizer PCB (A4). The count is latched into U12 when pulsed by the 10^6 strobe from the Error Counter 1 PCB (A6). When decoders U8 and U9 read I/O address 92H, U8, pin 13, is switched low and enables U12 to put the counter reading on the microprocessor data bus through octal buffer U15. Parity errors are totaled in an 8-bit counter since only one parity error can occur each superframe of 4760 bits, or 211 maximum per each 10^6 strobe cycle.

Component U15 is an Octal 3-State Buffer. It is enabled when a 9ØH address is active and U9, pin 11, is low. The microprocessor controls the I/O Read function which, in turn, controls whether U15 is operated to the Input Mode or the Output Mode. Component U14 is a similar 3-State Buffer that is enabled by the 93H address and allows the microprocessor to read the error status inputs as listed on the schematic (i.e., Loss of Signal, F-Frame, M-Frame, PRBS Sync, and BLUE Signal). Component U14 also provides response to the jumpers provided at J3. The jumpers are used to set the data rate transfer (or Baud Rate) for the optional RS-232 Interface PCB.

Components U11 and U14 also provide microprocessor access to the inputs from jumper block J3. Jumpers 1 through 3 select one (1) of the 8 available baud rates in units equipped with the RS-232 Interface (Option 257190). Jumper 4, when removed, forces the framing circuitry to be enabled (PCB A3), and is provided for test purposes only. Jumper 5, when removed, disables the framing circuitry for testing. Jumper 6 selects Asynchronous Error-Seconds when removed, and Synchronous Error-Seconds when in place.

Components U6 and U13 respond to the 94H address. Three of the five used outputs select which error type will be provided to the front panel OUTPUT-ERROR connector. One of the three gates, U6B, U6C, or U6D, will be enabled by a U13 output which is chosen to match the error type selected for display by the front panel switches. The selected signal is buffered by U7A which drives the $\overline{\text{Error}}$ line on the motherboard (for Error Burst measurement on PCB A10). The same line is logically combined with a signal loss line by U18, providing an error signal which thrashes around in the event of signal loss. This error

signal comes out of U18B, which is used as a 50-ohm TTL driver output. Similarly, the Gapped Clock signal is buffered by components U16B, U6B, and U7B to be a 50-ohm TTL output at the front panel OUTPUT-GAPPED CLOCK connector.

I. 8080 Processor PCB (A10)

The schematic of the Model 4657 Analyzer 8080 Processor printed circuit board (A10) is shown in Figure 7.19. With all the interactive components and interrelated circuits, the printed circuit board is the Central Processing Unit (CPU) of the Microcomputer circuits. The circuitry is arranged for on-board RAM at addresses EØØØH to FFFFH (RAM appears at each 2K block in this range) and for on-board ROM at addresses ØØØØ to 3FFFH.

Ports of significant interest are listed below:

- o Output Port E1H is used to drive the local printer data bus.
- o Output Port E2H provides handshake interfacing to the local printer.

1. Model 4657 Analyzer 8080 Processor PCB, General Description

A block diagram of the 8080 Processor (hereafter referred to as the Model 4657 CPU) printed circuit board is shown in Figure 4.14. The CPU printed circuit board is designed to meet microcomputer applications from the single board stand-alone application to the multiboard small system uses. This is achieved by providing on-board RAM and ROM capability and 24 pins of programmable I/O matched to system expansion capability through a bus connector. The microprocessor circuitry consists of three integrated circuit chips which include the 8080 Microprocessor, a clock generator, and a system controller. On-board decoders select appropriate RAM, ROM, and I/O ports from the address bus and generate address, data, and control busses which are buffered and then output to the system bus connector.

The on-board ROM memory consists of two 2764 EPROMS which provide 16K bytes. The on-board RAM memory consists of one 6116 CMOS RAM to provide 2K bytes. On-board memory address decoding is done to the 8K address block

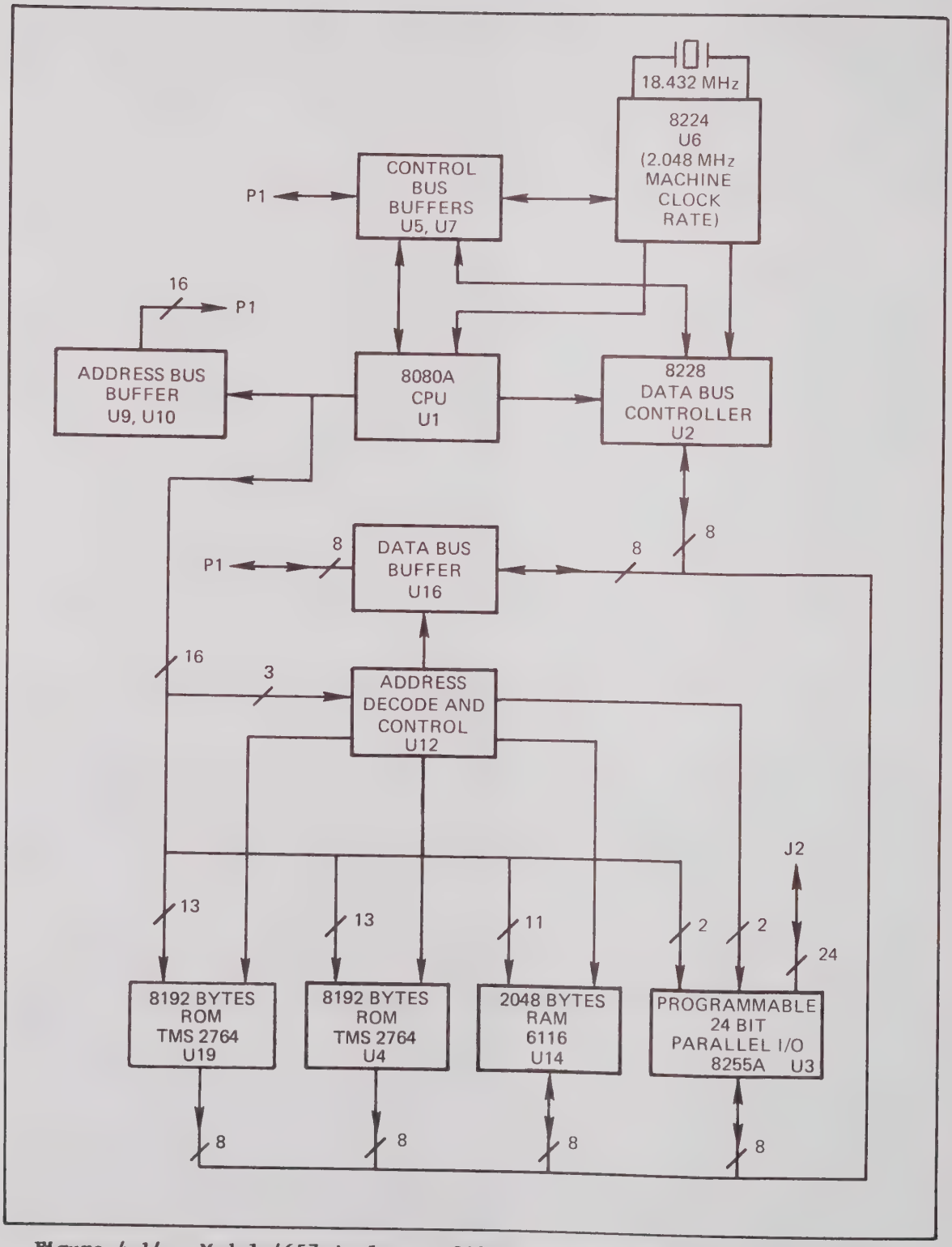


Figure 4.14. Model 4657 Analyzer, 8080 Processor PCB (A10), Block Diagram

level. The ROM socket U4 uses addresses ØØØØ to 1FFFH; ROM socket U19 uses addresses 2ØØØH to 3FFFH; and the RAM uses addresses EØØØH to FFFFH. RAM decoding is not unique and 2K of RAM may be accessed from either EØØØH to E7FFH, E8ØØH to EFFFH, FØØØH to F7FFH or from F8ØØH to FFFFH. See Figure 4.15.

The on-board I/O consists of one 8255 Programmable Peripheral Interface which provides 24 lines of programmable input or output. Ports A, B, C, and the Command Register are decoded for addresses EØ, E1, E2, and E3, respectively. However, the addressing is not uniquely decoded and the addresses EØ through FF are reserved for on-board I/O. Refer to the I/O map provided in Figure 4.16 for exact address locations.

Model 4657 CPU Printed Circuit Board Specifications. Specifications applicable to the 8080 Microprocessor printed circuit board are as follows:

Microprocessor

8080 Integrated Circuit (IC) using an 8224 IC Clock Generator and an 8238 (or 8228) IC System Controller. The Clock frequency is 18.432 MHz and the arrangement provides one interrupt.

Memory

ROM (Read Only Memory) using two 2764 IC's (Intel compatible or equivalent) for a total of 16K bytes.
RAM (Random Access Memory) using one 6116 IC for 2K Bytes (static RAM).

Power Requirements (As measured to Common)

+12V dc at 0.15 Amp (Max)
+5.0V dc at 1.33 Amp (Max)
-5.0V dc at 0.05 Amp (Max)

Input/Output (I/O)

One 8255A IC providing 24 lines of programmable I/O and interrupt available through a 50-pin connector mounted on the printed circuit board. The system bus is available through an 86-pin board edge connector.

Mating Connector and Pinout Charts. The microprocessor I/O is provided through a 50-pin female Amp connector 87476-7 (Scientific-Atlanta Part No. 86654) which mates to a 50-pin male Amp connector 86916-1 (Scientific-Atlanta Part No. 84379) using a 50-conductor flat cable (Scientific-Atlanta Part No. 84305). Table 4.1 lists the 50 I/O pinouts.

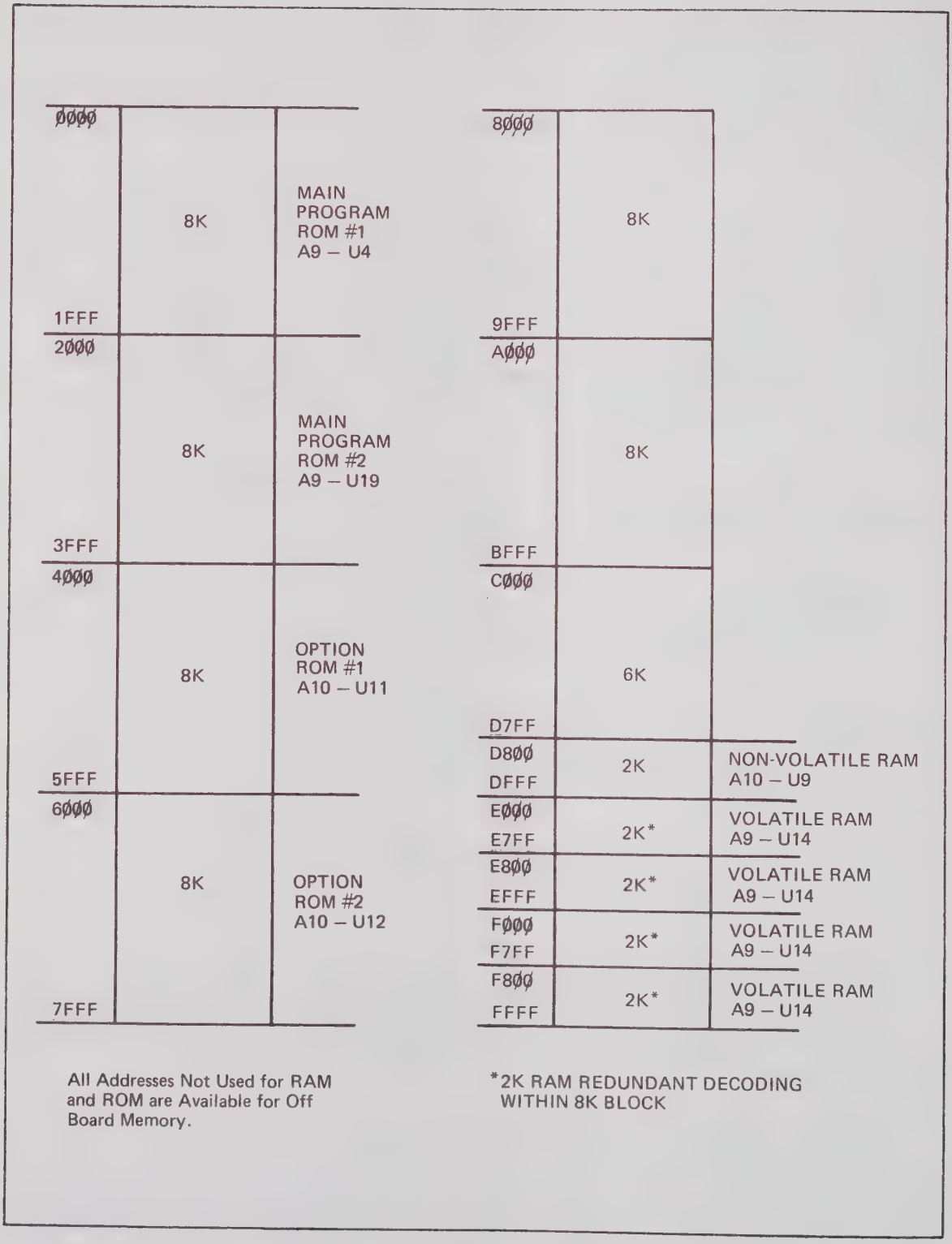


Figure 4.15. Model 4657 Analyzer, 8080 Processor PCB (A10), Memory Map

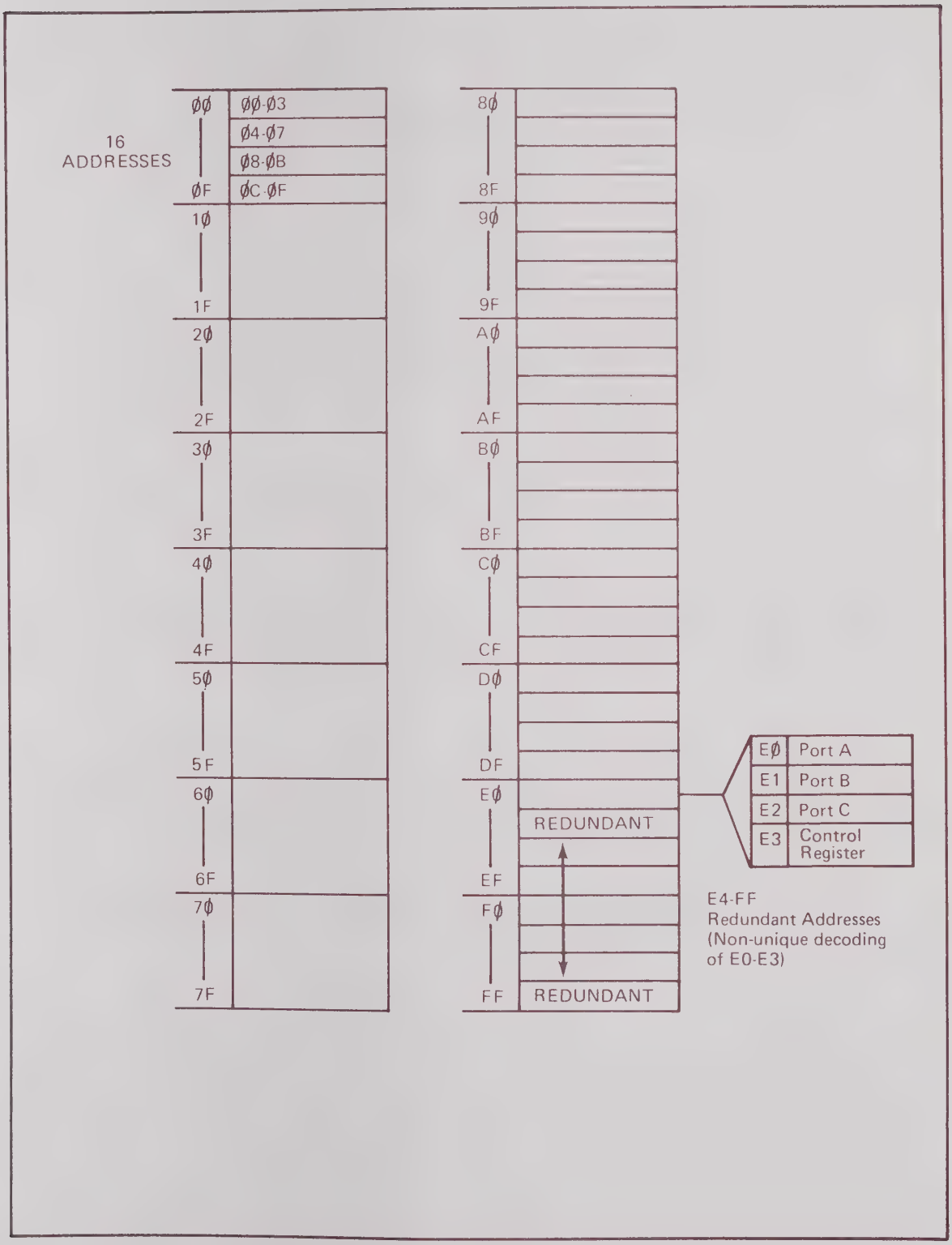


Figure 4.16. Model 4657 Analyzer, 8080 Processor PCB (A10), I/O Map

Table 4.1
Model 4657 Analyzer, 8080 Processor PCB (A10),
I/O Port Pinouts and Functions

PIN	SIGNAL	PIN	SIGNAL	PIN	SIGNAL
3	PCØ	19	PBØ	35	PAØ
5	PC1	21	PB1	37	PA1
7	PC2	23	PB2	39	PA2
9	PC3	25	PB3	41	PA3
11	PC4	27	PB4	43	PA4
13	PC5	29	PB5	45	PA5
15	PC6	31	PB6	47	PA6
17	PC7	33	PB7	49	PA7
				1 & 2	+5.0V DC

All even numbered pins (4 through 50) are Common (or Ground).

The system signaling is output through an 86-pin board edge connector located on the bottom of the printed board. Bus pinouts and functions are shown in Table 4.2.

Memory Map. The memory map for the Model 4657 Analyzer is shown in Figure 4.15. The Model 4657 CPU circuit resets to address Ø, and ROM is addressed starting at Ø.

Input/Output (I/O) Map. A complete I/O assignment map for the Model 4657 Analyzer CPU printed circuit board is shown in Figure 4.16. The microprocesor I/O uses EØ through FF as indicated with the I/O assignments shown on the map.

2. Model 4657 Analyzer 8080 Processor PCB, Detailed Circuit Description

This detailed circuit description does not include the internal operation of the 8080 Microprocessor or the peripherals. These functions are presumed to be known for explanation of other circuitry on the printed circuit board. For those who need more information, the 8080 Microprocessor is well documented in Application Notes and User Manuals. The 8080 Microprocessor is arranged in this group of circuits in the standard configuration. The primary advantage of the 8080 Microprocessor is having a simple, fixed hardware design. This leaves the bulk of Application Design in the software where cor-

rections, modifications, and updates are easily accomplished. The following descriptions use the positive true logic levels where a Logic "0" is equal to approximately 0 volts (<0.8V dc) and a Logic "1" is equal to approximately +5.0V dc (>2.4V dc).

Table 4.2
Model 4657 Analyzer, 8080 Processor PCB (A10),
System Bus Pinouts and Functions

Component Side		Circuit Side		Component Side		Circuit Side	
Pin	**Signal**	**Pin**	**Signal**	**Pin**	**Signal**	**Pin**	**Signal**
1	-12	A	-12	23	----	a	READY
2	+12	B	+12	24	IOR*	b	MEMR*
3	+5	C	+5	25	INTA*	c	ϕ2 CLK
4	+5	D	+5	26	IOW*	d	MEMW*
5	DCOM	E	DCOM	27	----	e	----
6	DCOM	F	DCOM	28	----	f	----
7	DCOM	H	DCOM	29	----	h	----
8	-5	J	-5	30	----	j	----
9	ABØ	K	AB1	31	----	k	----
10	AB2	L	AB3	32	INT0	l	I1
11	AB4	M	AB5	33	I2	m	I3
12	AB6	N	AB7	34	I4	n	I5
13	AB8	P	AB9	35	I6	p	I7
14	AB1Ø	R	AB11	36	I8	r	I9
15	AB12	S	AB13	37	I1Ø	s	I11
16	AB14	T	AB15	38	I12	t	I13
17	----	U	----	39	DCOM	u	DCOM
18	OSC	V	INT*	40	DBØ	v	DB1
19	BUSEN	W	RESO*	41	DB2	w	DB3
20	WAIT*	X	HLDA*	42	DB4	x	DB5
21	INTE*	Y	RESW*	43	DB6	z	DB7
22	HOLD*	Z	SYNC				

*Indicates inverse true signal.

Microprocessor Component Group. The standard three chip configuration of the 8080 Microprocessor consists of the 8080 IC (U1), an 8238 (or 8228) IC (U2) System Controller, and an 8224 IC (U6) Clock Generator. These three IC's are interconnected in the manufacturer's recommended configurations and operate as the "brains" of the printed circuit board.

The Clock Generator (U6) produces the different timing signals necessary for operation of the 8080 Microprocessor (U1) based on the frequency of the

crystal, Y1. The recommended crystal frequency of 18.432 MHz generates $\phi 1$ and $\phi 2$ frequencies at 2.048 MHz to cycle the 8080 Microprocessor circuits in 488 nanoseconds. The $\phi 2$ Clock signal is output to the bus connector at 2.048 MHz, which is easily divided down to standard reference frequencies for the Serial I/O Port and other uses. The crystal frequency, 18.432 MHz, is also output to the bus connector for use with other circuits.

The remaining signals in the Address Bus, the Data Bus, and the Control Bus will be described as they are used with other circuits.

Address Bus Buffers. Circuit chips designated U9 and U10 buffer the address bus onto the system bus connector for use by the expansion printed circuit boards. Each chip is actually a 3-state output transparent latch with its 3-state output control wired through U7 to the BUSEN signals.

The ICs used for U9 and U10 (74LS373) can each sink 24 milliamperes of current to provide adequate buffering for a heavily loaded system application. Note also that address decoding internal to the printed circuit board uses the unbuffered lines.

Data Bus Buffers. The component designated U16 provides bidirectional data bus buffering between the circuitry of U2 and the system data bus. Data flows into or out of the printed circuit board with the buffer direction (U16, pin 1) controlled by U11. The Data Bus Buffer (U16) always outputs data onto the bus except during Memory Read (MEMR), Input/Output Read (IOR), or Interrupt Acknowledge (INTA). These three signals are logic "ORed" to reverse operation of U16 to input data from the bus into the 8228 circuits whenever any are active.

The chip select line of U16 (pin 19) switches the 3-state inputs and outputs between the low impedance operate state to the high impedance off state. The circuitry provided with U13 drives the chip select function of U16 and also puts U16 into the high impedance (off state) whenever on-board RAM, ROM,

or I/O is selected or BUSEN is low. This feature avoids on-board memory or I/O driving the on-board data bus simultaneously against U16 during on-board memory or I/O reads.

Random Access Read/Write Memory (RAM). The RAM consists of a 6116 CMOS static RAM (2K x 8), providing 2048 bytes of usable memory. Eleven lines of the address bus connect to the RAM address to select a particular location and chip select for memory control of data transfer between the CPU and the RAM. The Memory Write (MEMW) is output from the 8238 chip (U2, pin 26) which is low during memory write instructions and high at all other times.

The Memory Write function strobes data bus data into the RAM when low and puts RAM data onto the data bus when high. The RAM select is decoded by U12 and can be jumper selected to place the RAM in any 8K block not occupied by the onboard EPROMs. In the Model 4657 Analyzer, the RAM is placed in the highest 8K block (EØØØ to FFFF).

Read Only Memory (ROM). Two 28-pin sockets, designated U4 and U19, are provided for on-board storage using two 2764 EPROMs. Both sockets will accept 2764 or 2732 type EPROMs.

The address bus lines AØ through A12 are wired directly to the U4 and U19 sockets. Chip select decoding is provided by U12. The ROM 1 (U4) will be selected whenever addresses AB15, AB14, and AB13 are low, which correspond to addresses ØØØØ to 1FFF. The ROM 2 (U19) will be selected when AB15, and AB14 are low and AB13 is high, which correspond to addresses 2ØØØ to 3FFF. The ROM outputs are 3-state and whenever chip select is enabled, the contents of the addressed location are output onto the data bus.

I/O Port. The I/O Port uses the circuitry of an 8255 IC (U3), which provides 24 lines of programmable input and output. These are available in three 8-bit bytes. The 8255 ports A, B, C, and Control are at Addresses EØ, E1, E2, and E3, respectively, (as described in the I/O Map) with seven more redundant

addresses through FF. Address bits AØ and A1 are input to the 8255 to select the internal registers and half the circuits of IC-U13 decode the Address bus to drive the 8255 chip select function.

During the I/O Address mode, the Address bus duplicates the 8-bit I/O Address in the lower (AØ through A7) and upper (A8 through A15) address bits. The IOR and IOW outputs of IC 8238 (U2) are logic ORed by U11 to generate an I/O Enable signal which is input to the quad NAND gate U13 (together with three Address lines, A5, A6, and A7) to generate the 8255 chip select function. Since A5, A6, and A7 must all be high (Logic level "1") to enable Chip Select, the 8255 Address must be higher than EØ and since A2, A3, and A4 are ignored, eight redundant I/O Addresses in the range EØ to FF will actually be decoded.

The Port A, Port B, and Port C outputs are wired to the top edge connector on the printed circuit board. The mating connector is attached to a flat cable and to provide signal isolation, alternate pins of the connectors are grounded. Since Port C provides handshaking for Port A and Port B in Mode 1 and Mode 2 of the 8255 circuit, two pins of Port C are wired to terminals E16 and E17 to provide I/O Interrupt capability. When terminal E16 is jumpered to terminal E15, the Interrupt function is provided to Port B; and similarly, terminal E17 jumpered to terminal E15 provides Interrupt function for Port A. More information is provided in the References. See the 8255 description for Programming Assignments.

Miscellaneous Circuitry. The Wait output is buffered and output off of the printed circuit board. The Ready input is also available on the system bus connector. The signals Interrupt Enable (INTE), Reset, Sync, and Hold Acknowledge (HLDA) are also buffered and output on the system bus connector. Input signals to the printed circuit board, such as Interrupt (INT), Hold, and Bus Enable (BUSEN), are also buffered. Other control bus signals, such as IOR, IOW, MEMR, MEMW, etc. are wired directly to and from the 8080 Microprocessor circuits.

J. Real-Time Clock PCB (A9)

A block diagram of the Real-Time Clock PCB is shown in Figure 4.17. The schematic is shown in Figure 7.17. This card provides a timekeeping function to permit the various types of timed error measurements and to allow logging of these measurements versus time. Other functions on the board are: (1) EPROMs for programs storage, (2) a CMOS RAM for data storage, (3) counters and latches for Error Burst measurements, (4) a "dead-man" timer to permit recovery from soft errors, and (5) a rechargeable battery for backup of the clock and RAM functions when external power is removed.

The timebase for the real-time clock consists of a 32768 Hz crystal (Y1), a phase-shifting network (C2 and R12), a trimmer capacitor (C1), and a 4060 CMOS 14-stage binary counter. U1, the Real-Time Clock, is interfaced to the microprocessor bus thorugh the data bus buffer (U14) and address decoding circuitry (U8B, and U15), and resides at port address 4ØH through 5FH, except for 58, 59, 5A and 5B. Figure 4.18 (6 sheets) is a data sheet on this device, the MM58167A.

The EPROMs, U11 and U12, provide a total of 16K bytes of program storage. They will accept Intel compatible 2732s or 2764s. Address decoding (U3A) is such that U11 resides at 4ØØØH to 5FFFH and U12 at 6ØØØH to 7FFFH. Jumper block J5, if installed, permits these EPROMS to be moved to other locations.

The nonvolatile CMOS RAM consists of U9, a 6116 static CMOS RAM, with a total capacity of 2K bytes. Address decoding is performed by U3B, U7, and U8, in such a manner that the RAM appears at D8ØØH to DFFFH. The nonvolatile RAM is used to store front panel set-ups and operating data during a power-down.

The Error Burst measurement process is fairly complex and is mostly contained in U16, U17, U18, U20, U21, and U23. First, a 1024 Hz (~ 1 millisecond) clock is acquired from the Real-Time Clock time base (U16). Q3 and Q13B isolate the time base from the burst counter when power is off. The divider is provided with space for a jumper block (J3) which, if installed, allows a different tap to be selected. Two D-flip-flops (U21A and U21B) serve as a

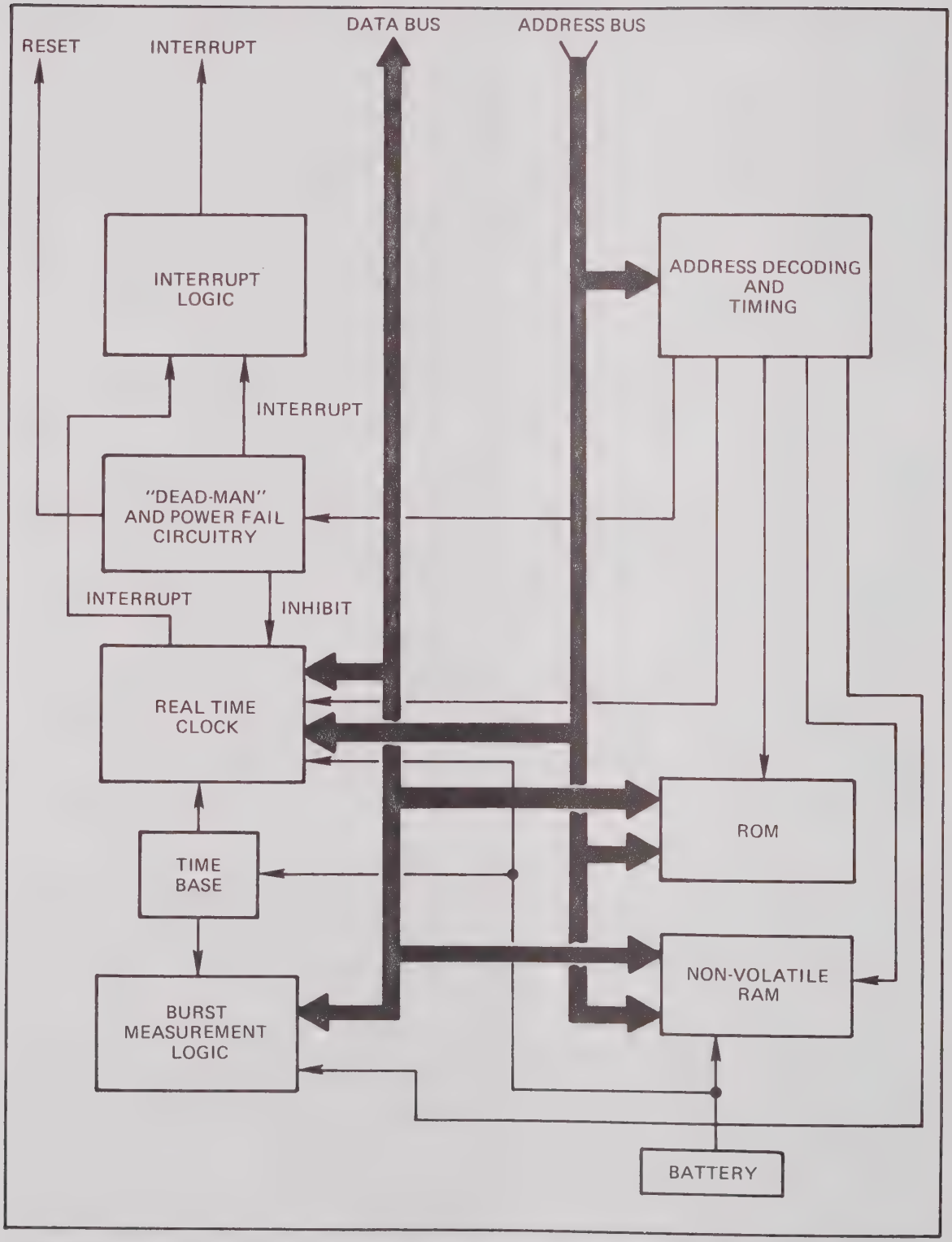


Figure 4.17. Model 4657 Analyzer, Real-Time Clock PCB (A9), Block Diagram

National Semiconductor

April 1982

MM58167A Microprocessor Real Time Clock

General Description

The MM58167A is a low threshold metal gate CMOS circuit that functions as a real time clock in bus oriented microprocessor systems. The device includes an addressable real time counter, 56 bits of RAM, and two interrupt outputs. A $\overline{\text{POWER DOWN}}$ input allows the chip to be disabled from the rest of the system for standby low power operation. The time base is a 32,768 Hz crystal oscillator.

Features

- Microprocessor compatible (8-bit data bus)
- 1/10,000 of a second through month counters
- 56 bits of RAM with comparator to compare the real time counter to the RAM data
- 2 INTERRUPT OUTPUTS with 8 possible interrupt signals
- $\overline{\text{POWER DOWN}}$ input that disables all inputs and outputs except for one of the interrupts
- Status bit to indicate rollover during a read
- 32,768 Hz crystal oscillator
- Four-year calendar (no leap year)
- 24-hour clock

Functional Description

Real Time Counter

The real time counter is divided into 4-bit digits with 2 digits being accessed during any read or write cycle. Each digit represents a BCD number and is defined in Table I. Any unused bits are held at a logical zero during a read and ignored during a write. An unused bit is any bit not necessary to provide a full BCD number. For example tens of hours cannot legally exceed the number 2, thus only 2 bits are necessary to define the tens of hours. The other 2 bits in the tens of hours digit are unused. The unused bits are designated in Table I as dashes.

The addressable portion of the counter is from 1/10,000 of a second to months. The counter itself is a ripple counter. The ripple delay is less than 60 μs above 4.0V and 300 μs at 2.0V.

RAM

56 bits of RAM are contained on-chip. These can be used for any necessary power down storage or as an alarm latch for comparison to the real time counter. The data in the RAM can be compared to the real time counter on a digit basis. The only digits that are not compared are the unit ten thousandths of seconds and tens of days of the week (these are unused in the real time counter). If the two most significant bits of any RAM digit are ones, then this RAM location will always compare.

The RAM is formatted the same as the real time counter, 4 bits per digit, 14 digits, however there are no unused bits. The unused bits in the real time counter will compare only to zeros in the RAM.

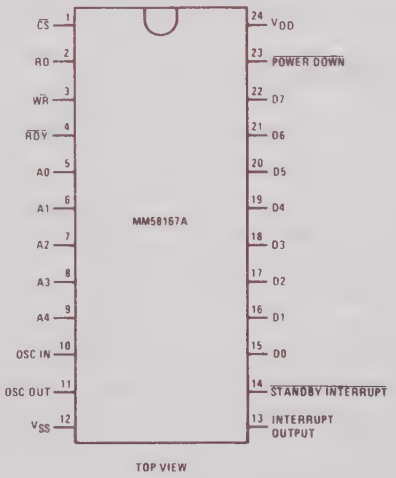
Interrupts and Comparator

There are two interrupt outputs. The first and most flexible is the INTERRUPT OUTPUT (a true high signal). This output can be programmed to provide 8 different output signals. They are: 10 Hz, 1 Hz, once per minute, once per hour, once a day, once a week, once a month, and when a RAM/real time counter comparison occurs. To enable the output a one is written into the interrupt control register at the bit location corresponding to the desired output frequency *(Figure 1)*. Once one or more bits have been set in the interrupt control register, the corresponding counter's rollover to its reset state will clock the interrupt status register and cause the interrupt output to go high. To reset the interrupt and to identify which frequency caused the interrupt, the interrupt status register is read. Reading this register places the contents of the status register on the data bus. The interrupting frequency will be identified by a one in the respective bit position. Removing the read will reset the interrupt.

The second interrupt is the $\overline{\text{STANDBY INTERRUPT}}$ (open drain output, active low). This interrupt occurs when enabled and when a RAM/real time counter comparison occurs. The $\overline{\text{STANDBY INTERRUPT}}$ is enabled by writing a one on the D0 line at address 16_H or disabled by writing a zero on the D0 line. This interrupt is not triggered by the edge of the compare signal, but rather by the level. Thus if the compare is enabled when the STANDBY INTERRUPT is enabled, the interrupt will turn on immediately.

Connection Diagram

Dual-In-Line Package



TOP VIEW

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Figure 4.18. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 1 of 8)

Absolute Maximum Ratings

Voltage at All Pins	$V_{SS}-0.3V$ to $V_{DD}+0.3V$
Operating Temperature	$-40°C$ to $85°C$
Storage Temperature	$-65°C$ to $150°C$
$V_{DD}-V_{SS}$	6.0V
Lead Temperature (Soldering, 10 seconds)	300°C

Electrical Characteristics $V_{SS}=0V$, $-40°C \le T_A \le 85°C$

Parameter	Conditions	Min	Max	Units
Supply Voltage				
V_{DD}	Outputs Enabled	4.0	5.5	V
V_{DD}	$\overline{\text{POWER DOWN}}$ Mode	2.0	5.5	V
Supply Current				
I_{DD}, Static	Outputs TRI-STATE® $f_{IN}=DC$, $V_{DD}=5.5V$		10	μA
I_{DD}, Dynamic	Outputs TRI-STATE $f_{IN}=32$ kHz, $V_{DD}=5.5V$ $V_{IH} \ge V_{DD}-0.3V$ $V_{IL} \le V_{SS}+0.3V$		20	μA
I_{DD}, Dynamic	Outputs TRI-STATE $f_{IN}=32$ kHz, $V_{DD}=5.5V$ $V_{IH}=2.0V$, $V_{IL}=0.8V$		5	mA
Input Voltage				
Logical Low		0.0	0.8	V
Logical High		2.0	V_{DD}	V
Input Leakage Current	$V_{SS} \le V_{IN} \le V_{DD}$	-1	1	μA
Output Impedance	I/O and INTERRUPT OUT			
Logical Low	$V_{DD}=4.5V$, $I_{OL}=1.6$ mA		0.4	V
Logical High	$V_{DD}=4.5V$, $I_{OH}=-400\ \mu A$	2.4		V
	$I_{OH}=-10\ \mu A$	0 8 V_{DD}		V
TRI-STATE	$V_{SS} \le V_{OUT} \le V_{DD}$	-1	1	μA
Output Impedance	$\overline{\text{RDY}}$ and $\overline{\text{STANDBY}}$ $\overline{\text{INTERRUPT}}$			
Logical Low, Sink	$V_{DD}=4.5V$, $I_{OL}=1.6$ mA		0.4	V
Logical High, Leakage	$V_{OUT} \le V_{DD}$		10	μA

Functional Description (Continued)

TABLE I. REAL TIME COUNTER FORMAT

Counter Addressed		Units D0	D1	D2	D3	Max BCD Code	Tens D4	D5	D6	D7	Max BCD Code
1/10,000 of Seconds	(00_H)	-	-	-	-	0	D4	D5	D6	D7	9
Hundredths and Tenths Sec	(01_H)	D0	D1	D2	D3	9	D4	D5	D6	D7	9
Seconds	(02_H)	D0	D1	D2	D3	9	D4	D5	D6	-	5
Minutes	(03_H)	D0	D1	D2	D3	9	D4	D5	D6	-	5
Hours	(04_H)	D0	D1	D2	D3	9	D4	D5	-	-	2
Day of the Week	(05_H)	D0	D1	D2	-	7	-	-	-	-	0
Day of the Month	(06_H)	D0	D1	D2	D3	9	D4	D5	-	-	3
Month	(07_H)	D0	D1	D2	D3	9	D4	-	-	-	1

(-) indicates unused bits

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Figure 4.18. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 2 of 8)

Functional Description (Continued)

TABLE II. ADDRESS CODES AND FUNCTIONS

A4	A3	A2	A1	A0	Function
0	0	0	0	0	Counter—Ten Thousandths of Seconds
0	0	0	0	1	Counter—Hundredths and Tenths of Seconds
0	0	0	1	0	Counter—Seconds
0	0	0	1	1	Counter—Minutes
0	0	1	0	0	Counter—Hours
0	0	1	0	1	Counter—Day of Week
0	0	1	1	0	Counter—Day of Month
0	0	1	1	1	Counter—Month
0	1	0	0	0	RAM—Ten Thousandths of Seconds
0	1	0	0	1	RAM—Hundredths and Tenths of Seconds
0	1	0	1	0	RAM—Seconds
0	1	0	1	1	RAM—Minutes
0	1	1	0	0	RAM—Hours
0	1	1	0	1	RAM—Day of Week
0	1	1	1	0	RAM—Day of Month
0	1	1	1	1	RAM—Months
1	0	0	0	0	Interrupt Status Register
1	0	0	0	1	Interrupt Control Register
1	0	0	1	0	Counters Reset
1	0	0	1	1	RAM Reset
1	0	1	0	0	Status Bit
1	0	1	0	1	GO Command
1	0	1	1	0	$\overline{\text{STANDBY}}$ $\overline{\text{INTERRUPT}}$
1	1	1	1	1	Test Mode

All others unused

Figure 4.18. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 3 of 8)

Functional Description (Continued)

The comparator is a cascaded exclusive NOR. Its output is latched 61 μs after the rising edge of the 1 kHz clock signal (input to the ten thousandths of seconds counter). This allows the counter to ripple through before looking at the comparator. For operation at less than 4.0V, the thousandths of seconds counter should not be included in a compare because of the possibility of having a ripple delay greater than 61 μs. (For output timing see Interrupt Timing.)

Power Down Mode

The POWER DOWN input is essentially a second chip select. It disables all inputs and outputs except for the STANDBY INTERRUPT. When this input is at a logical zero, the device will not respond to any external signals. It will, however, maintain timekeeping and turn on the STANDBY INTERRUPT if programmed to do so. (The programming must be done before the POWER DOWN input goes to a logical zero.) When switching V_{DD} to the standby or power down mode, the POWER DOWN input should go to a logical zero at least 1 μs before V_{DD} is switched. When switching V_{DD} all other inputs must remain between $V_{SS} - 0.3V$ and $V_{DD} + 0.3V$. When restoring V_{DD} to the normal operating mode, it is necessary to insure that all other inputs are at valid levels before switching the POWER DOWN input back to a logical one. These precautions are necessary to insure that no data is lost or altered when changing to or from the power down mode.

Counter and RAM Resets; GO Command

The counters and RAM can be reset by writing all 1's (FF) at address 12_H or 13_H respectively.

A write pulse at address 15_H will reset the thousandths, hundredths, tenths, units, and tens of seconds counters. This GO command is used for precise starting of the clock. The data on the data bus is ignored during the write. If the seconds counter is at a value greater than 40 when the GO is issued, the minute counter will increment; otherwise the minute counter is unaffected. This command is not necessary to start the clock, but merely a convenient way to start precisely at a given minute. (See Table III for reset format.)

Status Bit

The status bit is provided to inform the user that the clock is in the process of rolling over when a counter is read. The 1 kHz clock into the thousandths of seconds counter has a pulse width of 61 μs. If a read of the real time counter (any digits) is done during this 61 μs period the status bit will be set. This tells the user that the clock is rippling through the real time counter. Because the clock is rippling, invalid data may be read from the counter. If the status bit is set following a counter read, the counter should be reread.

The status bit appears on D0 when address 14_H is read. All the other data lines will be zero. The bit is set when a logical one appears. This bit should be read every time a counter read or series of counter reads are done. The trailing edge of the read at address 14_H will reset the status bit.

Oscillator

The oscillator used is the standard Pierce oscillator. Externally only 2 capacitors and the crystal are required. For micropower crystals a resistor in series with the oscillator output may be necessary to insure the crystal is not overdriven. This resistor should be approximately 200 kΩ. The capacitor values should be typically 20 pF–25 pF. The crystal frequency is 32,768 Hz.

The oscillator input can be externally driven, if desired. In this case the output should be left floating and the input levels should be within 0.3V of the supplies.

A ground line or ground plane between pins 9 and 10 may be necessary to prevent interference of the oscillator by the A4 address.

Control Lines

The READ, WRITE, and CHIP SELECT signals are active low inputs. The READY signal is an open drain output. At the start of each read or write cycle the READY line (open drain) will pull low and will remain low until valid data from a chip read appears on the bus or data on the bus is latched in during a write. READ and WRITE must be accompanied by a CHIP SELECT (see *Figures 3 and 4* for read and write cycle timing).

Test Mode

The test mode is merely a mode for production testing. It allows the counters to count at a higher than normal rate. In this mode the 32 kHz oscillator input is connected directly to the ten thousandths of seconds counter. The chip select and write lines must be low and the address must be held at IF_H.

Figure 4.18. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 4 of 8)

Functional Description (Continued)

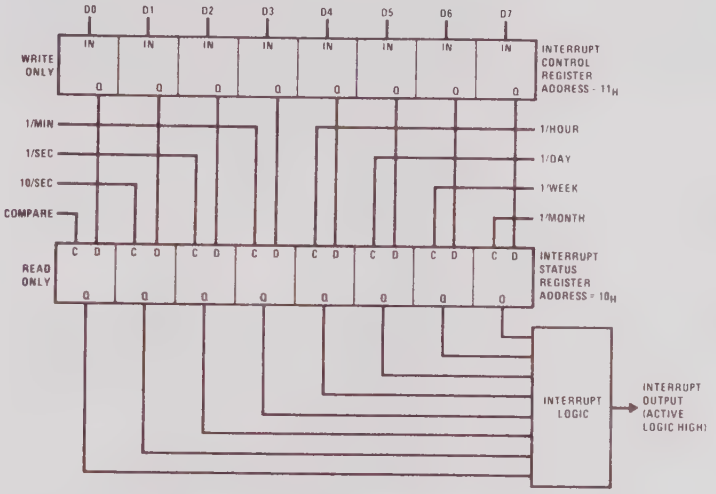


FIGURE 1. Interrupt Register Format

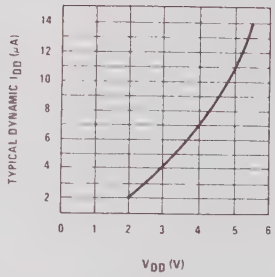


FIGURE 2. Typical Supply Current vs Supply Voltage

Interrupt Timing $-40°C \le T_A \le 85°C$, $4.5V \le V_{DD} \le 5.5V$, $V_{SS} = 0V$

Parameter		Min	Max	Units
t_{INTON}	Status Register Clock to INTERRUPT OUTPUT (Pin 13) High (Note 1)		5	μs
t_{SBYON}	Compare Valid to $\overline{\text{STANDBY INTERRUPT}}$ (Pin 14) Low (Note 1)		5	μs
t_{INTOFF}	Trailing Edge of Status Register Read to INTERRUPT OUTPUT Low		5	μs
t_{SBYOFF}	Trailing Edge of Write Cycle (D0 = 0; Address = 16_H) to $\overline{\text{STANDBY INTERRUPT}}$ Off (High Impedance State)		5	μs

Note 1: The status register clocks are: the corresponding counter's rollover to its reset state or the compare becoming valid. The compare becomes valid 61 μs after the 1/10,000 of a second counter is clocked, if the real time counter data matches the RAM data.

Read Cycle Timing $-40°C \le T_A \le 85°C$, $4.5V \le V_{DD} \le 5.5V$, $V_{SS} = 0V$

Parameter		Min	Max	Units
t_{AR}	Address Bus Valid to Read Strobe	100		ns
t_{CSR}	Chip Select to Read Strobe	0		ns
t_{RRY}	Read Strobe to Ready Strobe		150	ns
t_{RYD}	Ready Strobe to Data Valid		800	ns
t_{AD}	Address Bus Valid to Data Valid		1050	ns
t_{RH}	Data Hold Time From Trailing Edge of Read Strobe	0		ns
t_{HZ}	Trailing Edge of Read Strobe to TRI-STATE Mode		250	ns
t_{RYH}	Read Hold Time after Ready Strobe	0		ns
t_{RA}	Address Bus Hold Time from Trailing Edge of Read Strobe	50		ns

Note 2: If $t_{AR} = 0$ or $t_{DW} = 0$ and Chip Select, Address Valid, Read or Write are coincident then they must exist for 1050 ns.

Figure 4.18. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 5 of 8)

Write Cycle Timing $-40°C \le T_A \le 85°C$, $4.5V \le V_{DD} \le 5.5V$, $V_{SS} = 0V$

Parameter		Min	Max	Units
t_{AW}	Address Valid to Write Strobe	100		ns
t_{CSW}	Chip Select to Write Strobe	0		ns
t_{DW}	Data Valid before Write Strobe	100		ns
t_{WRY}	Write Strobe to Ready Strobe		150	ns
t_{RY}	Ready Strobe Width		800	ns
t_{RYH}	Write Hold Time after Ready Strobe	0		ns
t_{WD}	Data Hold Time after Write Strobe	110		ns
t_{WA}	Address Hold Time after Write Strobe	50		ns

Data bus loading is 100 pF
Ready output loading is 50 pF and 20 kΩ pull up
Input and output AC timing levels
Logical one = 2.0V
Logical zero = 0.8V

Read and Write Cycle Timing Diagrams

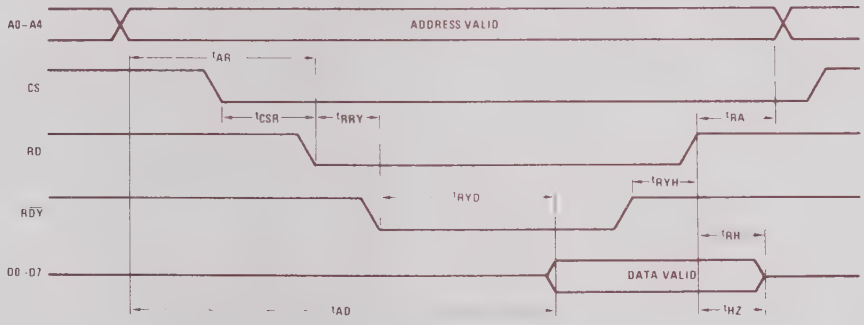


FIGURE 3. Read Cycle Timing

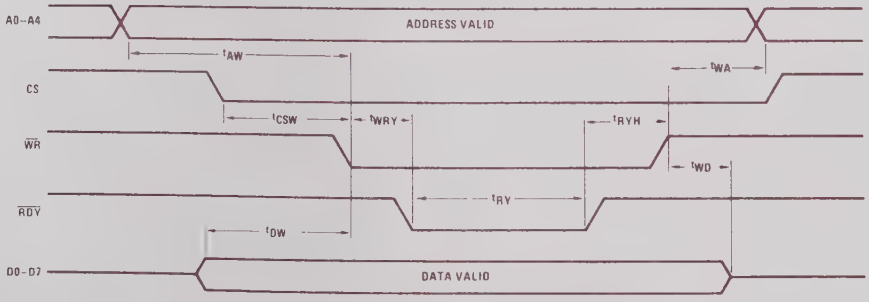
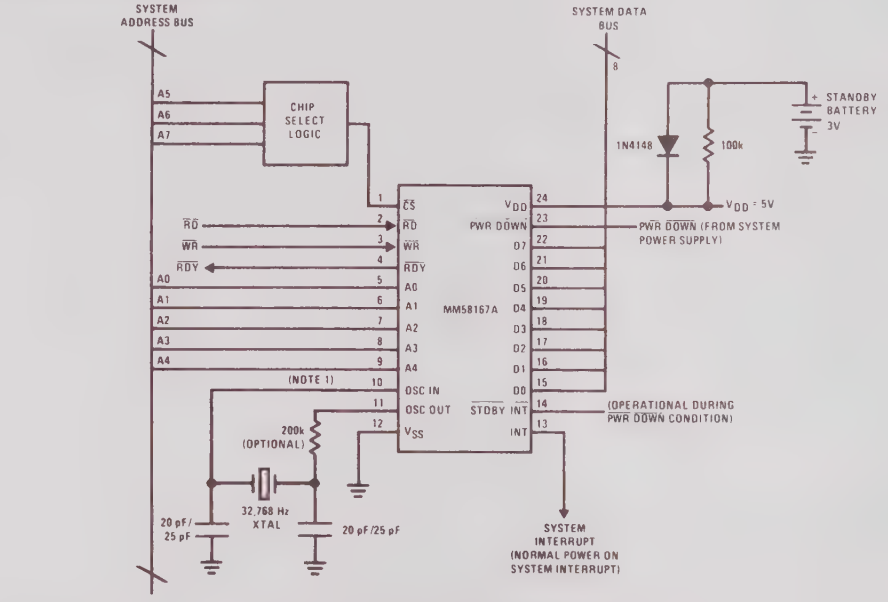


FIGURE 4. Write Cycle Timing

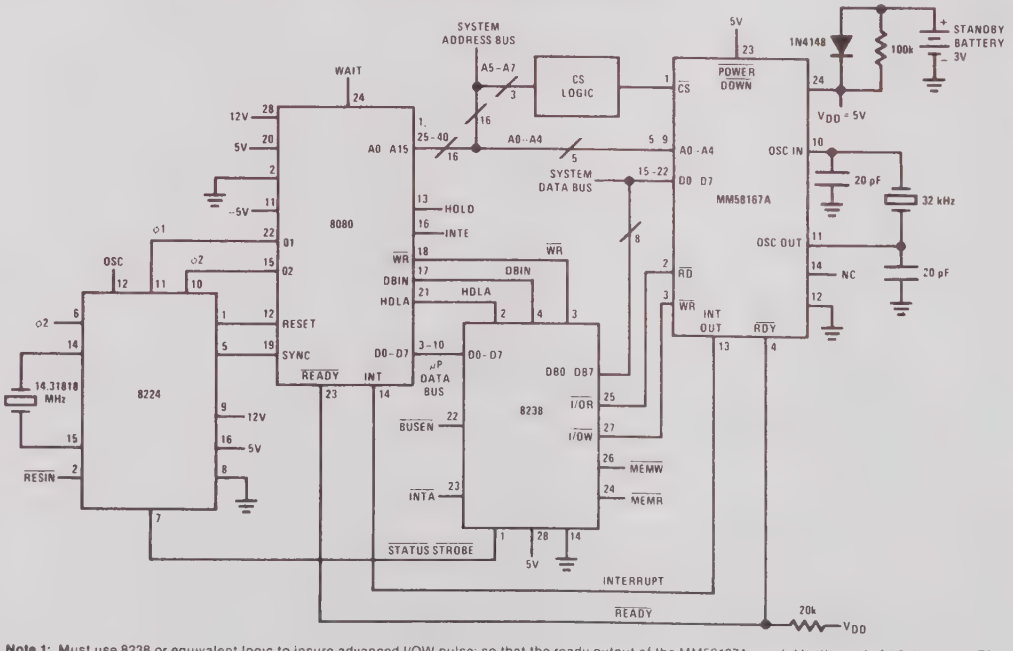
Figure 4.18. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 6 of 8)

Typical Applications



Note 1: A ground line or ground plane guard trace should be included between pins 9 and 10 to insure the oscillator is not disturbed by the address line

FIGURE 5. Typical Connection Diagram



Note 1: Must use 8238 or equivalent logic to insure advanced I/OW pulse; so that the ready output of the MM58167A is valid by the end of $\phi 2$ during the T2 microcycle

Note 2: $t_{\phi 2} \geq t_{RS8080} + t_{DL8238} + t_{WRY58167A}$

FIGURE 6. 8080 System Interface with Battery Backup

Figure 4.18. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 7 of 8)

Block Diagram

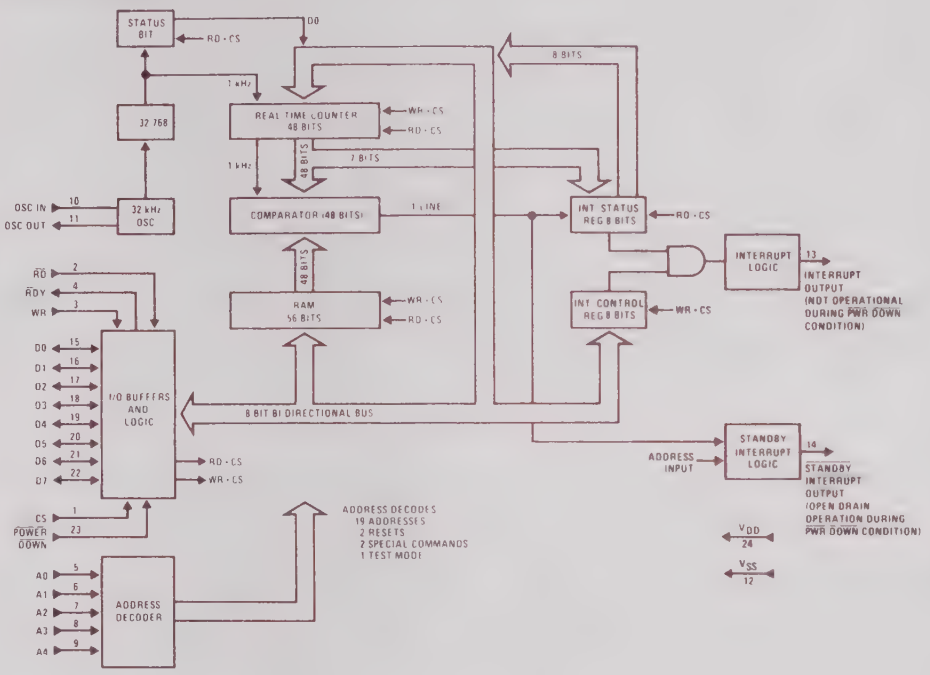
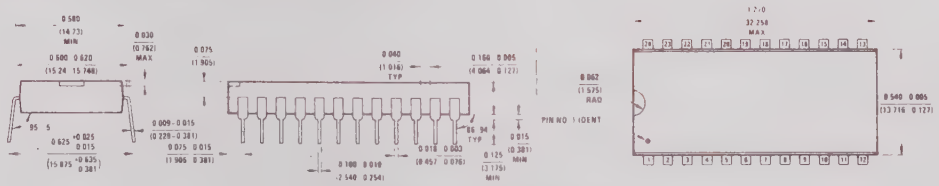


FIGURE 7

Physical Dimensions inches (millimeters)



Molded Dual-In-Line Package (N)
Order Number MM58167AN
NS Package Number N24A

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National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied, and National reserves the right at any time without notice to change said circuitry.

Figure 4.18. MM58167 Microprocessor Compatible Real-Time Clock (Sheet 8 of 8)

burst detector; U21A is set every millisecond and remains set in the absence of errors. At the beginning of the next millisecond, this state is transferred to U21B, providing a record of whether the preceeding millisecond contained an error. Thus, U21B remains clear for the duration of an error burst. U23B serves as an inverter to allow U18 to count the duration of each burst, up to a maximum of 125 milliseconds. At the end of an error burst, the rising edge on pin 9 of U21B increments the burst counter (U17) and sets the burst interrupt flip-flop (U23A). If this was the first burst since the interrupt was last serviced, the burst length is transferred to the output latch U20. The interrupt is serviced by writing to any port address in the range 58H to 5BH. The burst counter is also available in the bottom 3 bits of port 58H or 59H.

The "dead man" timer consists of U24B and U25. In the absence of regular retriggering, periodic resets are generated by this circuit, allowing the microprocessor to recover from a "soft" error hangup condition. Associated with the dead-man timer is the power-down timer which flags a power down condition to the microprocessor, then restricts access to the nonvolatile RAM and clock as power goes down. The dead-man timer is retriggered by reading port 58H or 5AH.

The rechargeable Ni-Cad battery, BT1, is equipped to charge from the +5 volt supply when the unit is on. In the absence of applied power, the battery supplies sufficient power to keep the RAM contents valid and the clock running. The capacity of the battery is sufficient to keep these circuits functioning for 3 to 6 months without external power.

4.4 MODEL 4657 ANALYZER OPTIONS

There are three options available to expand the operation of a Model 4657 Error Rate Analyzer. They are designated as:

A. Option 257189: IEEE-488 Interface Bus
B. Option 257190: RS-232C Interface Bus
C. Option Model 4650: Printer

The following paragraphs provide description and theory of operation for these options. The information is provided in the same sequence as listed above. Options 257189 and 257190 are designed to occupy card slot A8 in the card cage and only one will be available during normal analyzer operation. Either option can be added to an analyzer at a later date by qualified maintenance personnel using the Installation Procedures provided in the Operator's Manual. Option Model 4650 is an external electromechanical printer that is compatible with the analyzer circuitry with or without Option 257189 or 257190.

A. Option 257189: IEEE-488 Interface Bus PCB

A block diagram of the IEEE-488 Interface Bus PCB is shown in Figure 4.19. The schematic for the optional IEEE-488 Interface Bus PCB is shown in Figure 7.51. The IEEE-488 Interface Bus PCB interfaces the Model 4657 Analyzer circuits to the IEEE-488 Interface Bus through a rear panel connector. These circuits are configured for I/O operation with a base address of AØH. (See Table 4.6.)

Detailed Description, General. The IEEE-488 Interface Bus PCB provides the hardware interface to mate the Model 4657 Analyzer microprocessor system bus to the IEEE-488 bus in the Listener or the Talk configuration, but not as the system controller. Considerable software overhead is also required to initialize the 68488 integrated circuit, which contains the bus interface logic, and to process Controller commands. Once initialized with talker/listener protocol set-up, data transfer can flow smoothly using the available interrupts. IEEE Bus address switches are provided on the printed circuit board to establish talker/listener address definition. Data transfer to and from the printed circuit board by the microprocessor may be set up for either normal I/O or memory mapped I/O. The IEEE-488 Interface Bus PCB in the Model 4657 Analyzer is set up for normal I/O operation.

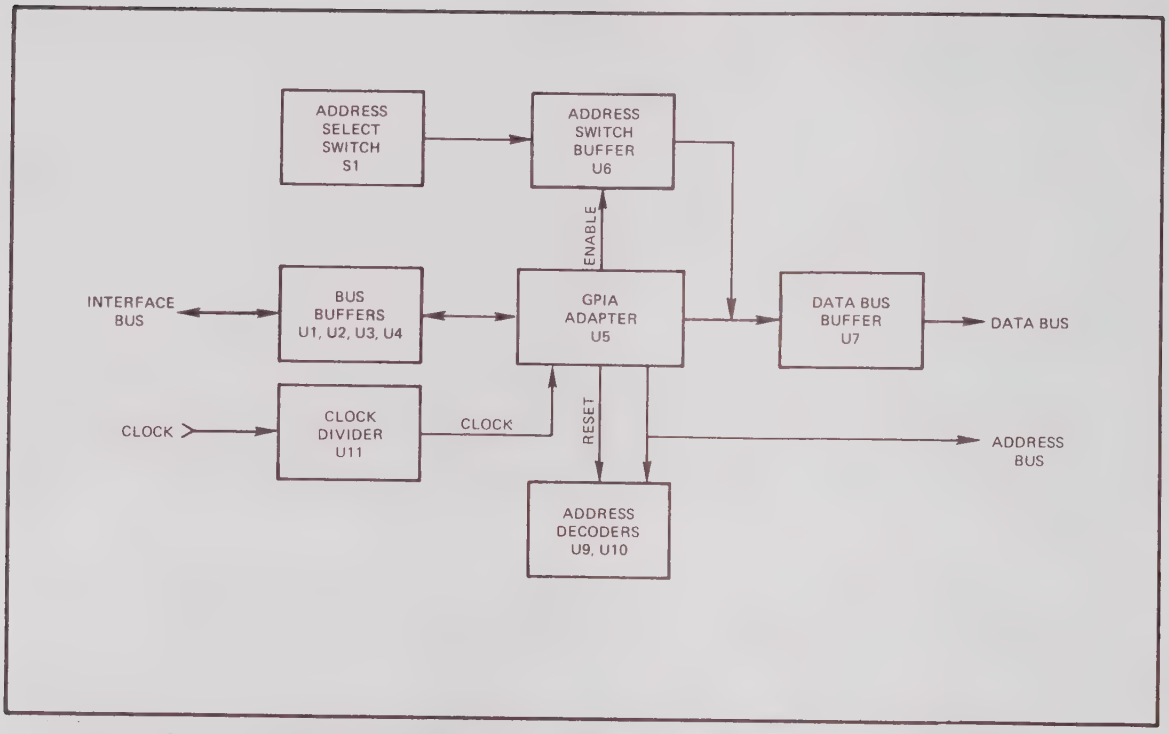


Figure 4.19. Model 4657 Analyzer, IEEE-488 Interface PCB (Option 257189), Block Diagram

To fully use the IEEE-488 Interface Bus PCB, the programmer must have a working knowledge of the IEEE-488 Interface Standard and Scientific-Atlanta adopted protocol. Descriptions in this section will be limited to port assignments and transfer of data with the 68488 IC. Some peculiarities of the software interface will not be described. For example, there is no explanation of how to process commands in the command pass through register or parallel poll register.

1. IEEE-488 Interface Bus PCB Specifications

Specifications applicable to the IEEE-488 Interface Bus PCB are as follows:

Primary Logic Element - 68488 General Purpose Interface Adapter automatically handles all handshake protocol on the IEEE-488 bus.

Power Requirements - +5.0V dc at 0.92 Amps (Max.)

IEEE Bus Connector - Connector J2 is compatible with Scientific-Atlanta No. 85050 using 26-conductor flat cable, Scientific-Atlanta No. 82495, to Scientific-Atlanta No. 88368 IEEE Rear Panel Connector.

Mating Connector and Pinout Chart. IEEE-488 Interface Bus PCB functions are provided through an 86-pin board edge connector located on the bottom of the printed circuit board. Signal pinouts are labeled on the schematic (see Figure 7.51).

2. Detailed Circuit Description

The IEEE-488 Interface Bus PCB contains a single LSI-IC which performs most of the bus logic. The remaining components provide the bus interface, buffering and decoding. The 68488 IC, U5, automatically handles all handshake protocol on the IEEE-488 bus. If this were attempted using discrete logic, all necessary components could not be contained on a single printed circuit board. The IC's U1 through U4 buffer drive the IC-U5 I/O into IEEE-488 bus compatible levels. The IC's U9 and U10 decode the system address bus, and IC's U6 and U7 buffer the data bus and remaining various logic gate signals.

The following detailed circuit descriptions do not explain operation of the logic or the operation of the IEEE-488 bus since these functions are accomplished internally to circuit of IC-U5. The descriptions do involve the connection of the IC-U5 between the IEEE-488 and the 8080 Microprocessor system bus.

IC-U5, The 68488. This single IC automatically handles all handshake protocol on the IEEE bus. Features provided by this circuitry include the following:

1. Single or dual primary address recognition
2. Secondary Address capability
3. Complete Source and Acceptor handshake
4. Programmable Interrupts

5. RFD hold-off to prevent data overrun
6. Serial and Parallel polling capability
7. Talk-only or listen-only capability
8. Synchronization trigger output

The 68488 is 6800 bus compatible and requires some adapter logic to make it 8080 bus compatible. The bus difference is basically that the 6800 is enabled and the clock input strobes data from the microcomputer bus into the IC, whereas the 8080 components are enabled and have separate I/O read and write pulses to strobe the data. The 68488 does not provide IEEE-488 bus termination and therefore requires the additional circuitry of bus drivers and terminators to provide buffering of the system data bus to the 8080 Microprocessor.

The schematic in Figure 7.57 shows that all of the 68488 IEEE bus connections are buffered into the IEEE bus. The DIOØ-DIO7 lines are bi-directional with TR2 (pin 27) output controlling the U3 and U4 buffer direction. The functional direction of signals Data Available (DAV), Ready for Data (RFD), and Data Accepted (DAC) are also controlled by TR2. Note that the functions labeled Attention (ATN), Remote Enable (REV), and Interface Clear (IFC) are always inputs. The function Service Request (SRQ) is always an output and the direction of End of Identity (EOI) is controlled by TR1 (pin 28).

The circuits provided by U1 through U4 include IEEE bus drivers and terminators to make the 68488 electrically IEEE bus compatible. The system data bus, DBØ through DB7, connect directly to the 8080 Microprocessor data bus.

The Address Switch Enable (ASE) function at pin 4 of the 68488 enables U6 to put the address switch setting onto the data bus when the microcomputer is addressing Register 4 (which is actually the switch setting). The Chip Select function (U5, pin 3) is enabled when addressed through the operation of either U9 or U9/U10 decoders. Register Select Inputs (RSØ, RS1, and RS2) connect directly to System Address Bits (ABØ, AB1, and AB2, respectively) to select the various registers for I/O data transfers.

The 68488 Clock Input (pin 6) is connected to a divide-by-two circuit of the 2.048 MHz Phase 2 Clock (ϕ2CLK) of the 8080 Microprocessor bus to produce

a 1.024 MHz clock. Since the 68488 circuit uses the trailing edge of its clock input to strobe data for input, the clock input is also synchronized to the 8080 Microprocessor bus to correctly transfer data. This circuit is described later under the paragraph title "68488 Clock Synchronizing Circuit".

The 68488 Read/Write (R/W) function is brought to a terminal for jumpering to IOW (for Normal I/O) or the MEMW (for Memory Mapped I/O). The reset line connects directly to the system control bus for system resets. The Interrupt Request (IRQ) output function is brought to a terminal where it is connected to and inverted by U8B and the output is brought to another terminal. The first terminal (providing the IRQ function) permits jumpering to the single interrupt from the 8080 Microprocessor printed circuit board which is a negative true interrupt. The second terminal (providing the IRQ function) permits jumpering to one of the interrupts provided by the Interrupt Controller which are positive true interrupts. Note that the schematic shows the 68488 Trigger Output (U5, pin 24) is also wired to jumper terminal for picking up an interrupt.

68488 Clock Synchronizing Circuit. The 68488 IC is a dynamic device requiring continuous clocking with a frequency between 100 kHz and 1.0 MHz. Additionally, during I/O transfers, the trailing edge of the clock signal latches bus data into one of the eight addressed latches. The U11-D flip-flop is used to divide the 8080A Microprocessor 2.048 MHz Phase 2 Clock down to 1.024 MHz.

The phase of the flip-flop is controlled by gating the U11 internal feedback (U11, pin 6 shown as Q output) with the sync signal on the 8080 Microprocessor control bus. If the sync pulse is high during the T1 cycle of the 8080 Microprocessor, and if the U11 Q output (pin 5) is low at the beginning of T1, it is allowed to switch high on the next clock pulse. If the U11 output is high at this time interval, it is held high. The U5 clock input is now synchronized with the 8080 Microprocessor data transfer and produces a clock trailing edge during data valid on load to U5 data transfers.

Address Switch Enable. Register 4, shown on the 68488 data sheet, does not actually exist within the 68488 IC. During "reads" from this register, the 68488 outputs the inverted Address Switch Enable (ASE) at pin 4 which is used as an enable for a data bus buffer and puts the switch setting on the data bus.

The IEEE bus address switch S1 is an eight-position single pole switch with pull-up resistors provided by U13 and connected to U6 operating as an octal 3-state data bus buffer. When U6 is enabled by ASE, an address switch setting is put on the data bus to be read by the 8080 Microprocessor. Note that during initial power-up of the 68488, this address has to be read by the 8080 Microprocessor and then loaded into the 68488 address register to define the IEEE bus address for the 68488. The IEEE-488 bus address is a 5-bit address and the other 3 switch positions can be user defined through software for a desired function, such as talk-only or listen-only definition.

Address Decoding. Using the proper jumper selections, address decoding can be set up for either Memory Mapped I/O (16 line address) or for normal I/O (8-line address). The 16-line system address bus is used for both memory and I/O accesses, but during the I/O operations the 8-line address is duplicated on the upper and lower halves of the 16-line address bus. Circuits provided by U9, U10, and U12-A are grouped onto the address lines to provide decoding for either normal I/O or Memory Mapped I/O.

For normal I/O operation, U9 decodes three lines of 8-line I/O address (AB15, AB14, and AB13) to break the 256 address range into 8 blocks of 32 addresses. Terminal E18 is jumpered to one of the U9 outputs (E1 through E8) to select a 32-address block. At this time the U12-A output, which is gating AB3 and AB4 (the same as AB12 and AB11), and the selected U9 output will be high whenever any of the lower 8 addresses of the selected 32 address blocks are accessed. The U12-A signal function is inverted by U8-C to become the chip select for both the 68488 IC and U7, the bi-directional data buffer. The IC-U10 is not used for normal I/O.

B. Option 257190: RS-232C Interface Bus PCB

A block diagram of the optional RS-232C Interface Bus PCB is shown in Figure 4.20. The schematic is shown in Figure 7.55. The RS-232C Interface Bus PCB interfaces the Model 4657 Analyzer circuits to a compatible modem through a rear panel connector. These circuits are configured for I/O operation at RS-232C signal levels using the base address of 8ØH through 87H.

Detailed Description; General. The block diagram of the RS-232C Interface PCB (Figure 4.20) shows that the circuitry basically provides a Serial I/O function, a Programmable Timer function, and a Rate Multiplier function.

The ϕ2 clock at 2.048 MHz is multiplied by 9/10 in the decade rate multiplier (U24) and provided to the 8253 timer (U12) as CLKØ at 1.8432 MHz. The 8253 timer divides down from this signal in accordance with baud rate jumpers installed on the Error Counter 2 & 3 PCB (A7) and provides the 8251A USART (U11) with a TX/RX clock at 16X, the operational baud rate.

The 8251A USART handles all asynchronous data communication between a System Controller (through a compatible modem) and the Model 4657 Analyzer. Interface buffers (U2 and U3) are provided to the 8251 serial I/O lines to allow EIA RS-232 signal levels. The buffers also provide that compatible output signals identified as Data Terminal Equipment (DTE) or Data Communication Equipment (DCE) will be as specified in RS-232C. The RS-232C Interface PCB uses ports 8ØH and 81H for the 8251A programmable interface component and ports 84H and 87H for the 8253 programmable timer component.

1. RS-232C Interface Bus PCB Specification

Power Requirements

+5.0V dc at 0.52 Amps (Max.)
+12.0V dc at 0.025 Amps (Max.)
-12.0V dc at 0.23 Amps (Max.)

RS-232 Interface Connector

Connector J2 is compatible with Scientific-Atlanta Part No. 85050, using 26-conductor flat cable, Scientific-Atlanta Part No. 82495, to a Scientific-Atlanta Part No. 86242 "RS-232" rear panel connector.

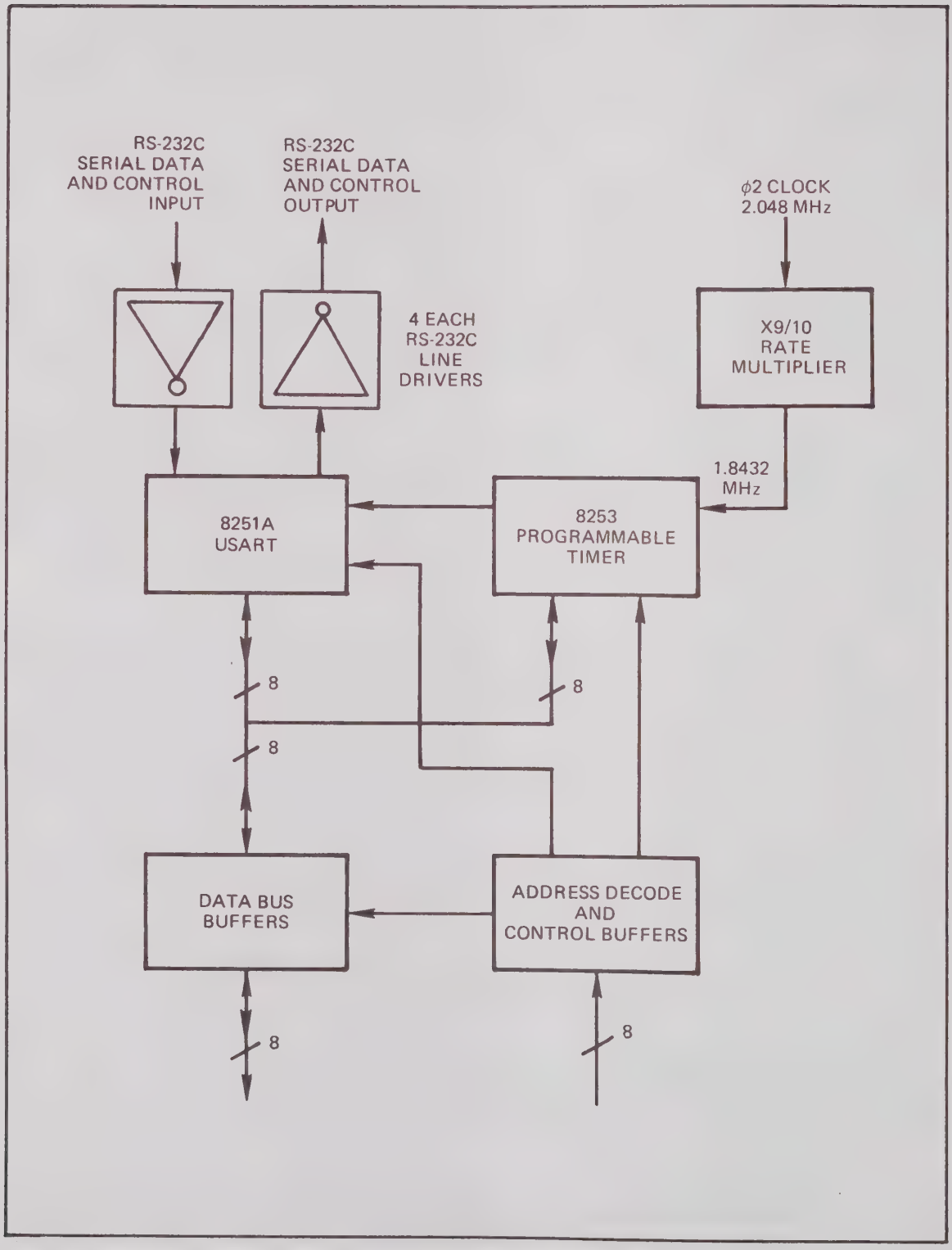


Figure 4.20. Model 4657 Analyzer, RS-232C Interface PCB (Option 257190), Block Diagram

Mating Connector and Pinout Chart

The RS-232C Interface functions are provided through an 86-pin board edge located on the bottom of the printed circuit board. All signal pinouts are labeled on the schematic (see Figure 7.55).

2. Detailed Circuit Description

The circuit components used by the RS-232C Interface PCB are 8080 Processor bus compatible and should be considered as system elements rather than individual components. The necessary jumpers and the proper command sequences have been identified in Chapter 3 of the Operator's Manual to prepare this PCB to be compatible with the Model 4657 Analyzer in most common environments. The following paragraphs identify other features available but not generally used in equipment of this design.

a. EIA RS-232 DCE or DTE Arrangement

Three pairs of signal wires must be cross connected for the DCE or DTE configuration if the signals are to be used. There are many applications which use transmit data (TXD) and receive data (RXD) only and do not connect the Data Terminal Ready to Send (RTS) and Clear to Send (CTS) functions.

The six signal functions should be wired according to one of the following tables to complement the equipment configuration:

DCE Arrangement

RXD: jumper E23 to E20
TXD: jumper E21 to E22

Optional

DTR: jumper E30 to E28
DSR: jumper E29 to E31
RTS: jumper E19 to E16
CTS: jumper E18 to E17

DTE Arrangement

RXD: jumper E20 to E21
TXD: jumper E22 to E23

Optional

DTR: jumper E31 to E30
DSR: jumper E28 to E29
RTS: jumper E18 to E19
CTS: jumper E16 to E17

b. Timer Connections

Three separate timer inputs and outputs are available and may be: (1) jumpered in cascade, (2) jumpered to the $\phi 2$ clock, or (3) jumpered to provide

interrupt. Select the desired Timer connection listed in Table 4.3 to complement the circuit arrangement.

Table 4.3
Timer Connections

Timer In/Out	Available Signals	
CLK Ø = E33	OSC E62	Interrupts
CLK 1 = E41	ϕ2 E44	IØ = E45
CLK 2 = E38	Baud Rate E35	I1 = E49
Out Ø = E34		I2 = E46
Out 1 = E43		I3 = E5Ø
Out 2 = E39		I4 = E47
Outputs may be connected to		I5 = E51
clock input to cascade timers		I6 = E48
		I7 = E52
		I8 = E57
		I9 = E56
		I1Ø = E55
		I11 = E58
		I12 = E54
		I13 = E59
		I14 = E53
		I15 = E6Ø

Additionally, three gate inputs for the timers are available for timer inhibits:

GØ = E32
G1 = E42
G2 = E4Ø

The timers are actually 16-stage counters which can (through software) be set to operate in several modes. For baud rate generator, timers could be set for squarewave rate generator mode, and then set for binary or BCD division. To set a desired baud rate using the 2.048 MHz ϕ2 clock, divide 2048000 by the baud rate and enter the rounded off whole number into the counter's inputs. Note also that the 8251A has an internal programmable divider which must be correctly programmed to set the desired baud rate.

c. Serial Interrupts

Three interrupt functions are available at the 8521 Programmable Communication Interface circuit arrangement. These functions are: (1) TXE (Transmit Empty, terminal E37) which will provide indication that transmit register and transmit buffer register is empty, (2) TXRDY (Transmit Ready, terminal E61) which will provide indication that the transmit buffer is empty and the transmitter is sending the last byte, and (3) RXRDY (Receive Ready, terminal E36) which will provide indication that the receiver buffer is full and should be ready.

Loading the transmit buffers and reading the receive buffer will reset the corresponding interrupt function. Either or both buffer circuits may be jumpered to the same interrupt interval available to the timer. (Refer to b. Timer Connections).

d. Address Assignments

Eight separate four-address groups in the range from 8Ø to 9F are decoded and connected to jumper pins. The Serial I/O Port and the Interrupt Controllers use only two addresses of the four-address groups, and the Timer uses all four addresses of its assigned group. The following table identifies the jumper pin and the assigned function.

Port	Address
E9 = Int. Cont. 1 E9	E1 = 8Ø-83
E1Ø = Int. Cont. 2 E1Ø	E2 = 84-87
E13 = Timer	E3 = 88-8B
E14 = Serial I/O	E4 = 8C-8F
	E5 = 9Ø-93
	E6 = 94-97
	E7 = 98-9B
	E8 = 9C-9F

e. Address Decoding and Data Bus Buffering

Component U5 is a 3-to-8 line decoder with three enable inputs of which two are low active and one is high active. The two low active enable inputs (U5, pins 4 and 5) are wired to Address bus lines AB5 and AB6, respectively. The high active input (U5, pin 6) provides an input to Address AB7 which is gated with BUSEN in the U9B circuit. Component U5 is enabled when AB5 and AB6 are low and AB7 is high. This corresponds to 1ØØXXXXX on the Address bus which is the range from 8Ø to 9F.

Addresses AB2, AB3, and AB4 are wired to U5, pins 1, 2, and 3, respectively. These addresses are decoder inputs and select which of the eight active low outputs will be operated when U5 is enabled. The schematic shows these outputs are wired to jumper pins and will assign address for circuits of U1, U2, U3, and U6. The circuit of U1 will decode both addresses ABØ and AB1, while U2, U3, and U6 decode ABØ only.

The function BUSEN disables U5 for applications where an external device takes control of the system bus (i.e., a DMA controller). The U9A circuit provides chip select of U1, U2, U3, and/or U6 and also enables the data bus buffer (U4, pin 19) whenever a chip select is active. An indication is also provided showing an on-board device is being accessed by the microprocessor.

Component U4 is also a bi-directional buffer which is required since U1, U2, U3, and U6 cannot drive the system bus without assistance. The driving direction of U4 is controlled by the IOR signal. The function of U4 is to either buffer the data bus on to the printed circuit board when IOR is high, or buffer on-board data onto the system bus when IOR is low. The U4 circuit is only active when an on-board chip is selected.

f. 8251A Programmable Communication Interface (U6)

The 8251A Programmable Communications Interface component U6 operates (1) bi-directionally with the data bus, (2) using Address ABØ to select the internal command or data register, (3) using various control bus lines to manage

the data transfer, (4) using the U1 timer outputs to set the band rates, and (5) using the U7 and U8 circuits to produce EIA RS-232 levels.

The U6 data bus is bi-directional with direction controlled by the IOR and IOW signals with buffering onto the system bus provided through the operation of component U4. The 8251A circuit has command and data transfer modes which are selected by the address AB$\emptyset$. (It should be noted that several command modes are multi-byte sequences to the same address and must be accomplished in a correct sequence.) The address AB$\emptyset$-low selects data and AB$\emptyset$-high selects command and status. The system control bus signals used are RESET for initialization, and IOR/IOW for outputting/inputting data to/from the data bus, respectively.

The Transmit Clock (TXC) function (U6, pin 9) and the Receive Clock (RXC) function (U6, pin 25) are wired together on the printed circuit board. This restricts the U6 circuit to transmitting and receiving at the same rate. The TXC and RXC functions have a common connection to terminal E35 for jumpering to one of the timer outputs (terminal E34, E43, or E39) to set the data transfer rate. Refer to B. Timer Connections for typical timing connections and program divider constants. The 8251A serial outputs: (1) are at TTL drive levels, (2) are unipolar, and (3) in order to be EIA RS-232 compatible, must be level shifted and made bipolar. Similarly, RS-232 bipolar inputs must be shifted to TTL levels for normal operation.

The 1488-type component (U7) circuit can input the TTL levels from U6 and output the required +12/-12V bipolar RS-232 signal levels required for functions TX, Syn Det, RTS, and DTR, as shown on the schematic. The 390 pF capacitors connected on the U7 outputs control the signal rise time to be RS-232 compatible.

The 1489-type component (U8) circuit is used to accept bipolar RS-232 signal inputs and provides TTL logic level outputs. The 0.001 capacitors used on the signal inputs provide RC filtering of the received signal. The 39K resistor will shift the threshold level slightly positive so TTL level inputs may also be used.

g. 8253 Programmable Interval Timer (U1)

The 8253 Programmable Interval Timer (U1) will: (1) operate bi-directionally with the data bus and (2) use various control bus lines to manage the data transfer. Component U1 is provided with clock and gate inputs and outputs wired to jumper pins. The U1 data bus is bi-directional with the direction being controlled by the IOR and IOW signal enabled by chip selection pin 1. Signals are buffered onto the system bus by U4, since U1 cannot drive a fully loaded system bus directly. The chip select function (U1, pin 1) is wired to terminal E10 where it can be jumper assigned to an address.

The IOR and IOW are the only control bus inputs and provide control of the data read and write functions. Addresses AB$\emptyset$ and AB1 are input from the address bus and select the appropriate internal data registers. The clock inputs (U1, pins 9, 15, and 18) are wired to board terminals where they can be jumpered to either the primary oscillator (18.432 MHz Standard) from terminal E62, the Phase (2) Clock (2.048 MHz Standard) from terminal E44, or cascaded to another timing source output. These clock inputs are provided at U1, pins 10, 13, and 17, or terminals E34, E48, and E39, respectively. The timer outputs can be jumpered to an interrupt for timing measurements or to provide timing for the 8251 component (U6) circuits. A 10K pull-up resistor on the U1 input is provided to enable the gate inputs (U1, pins 11, 14, and 16) and to terminate unused clock inputs.

C. Option Model 4650: Dot Matrix Printer

The Dot Matrix Printer consists of several major components. The printer mechanism and Control/Drive Card are purchased items and not manufactured by Scientific-Atlanta, but the remaining components (i.e., case, Printer I/O PCB, and switch) are made to Scientific-Atlanta specifications with assembly and final testing provided by Scientific-Atlanta. Consequently, the printer mechanism and Control/Drive Card are not considered field repairable although this publication reprints some information from the Users Manual provided by Star Micronics, Inc., 200 Park Avenue, Pan Am Bldg., suite 2308, New York, NY, 10166, to assist troubleshooting should the need arise. This information

follows the description of the Scientific-Atlanta Printer I/O PCB and Switch Panel.

1. Printer I/O PCB, 4650 (A2)

The Dot Matrix Printer I/O PCB is contained in the Dot Matrix Printer housing and interfaces with the Model 4657 through the W1 cable. The schematic diagram for the Printer I/O PCB is shown in Figure 7.60. The Printer I/O PCB interfaces the Control and Data Bus from the 8080 Processor PCB (A9) to the printer Control/Drive Card so the data bit lines of the printer controller (DBØ to DB7) are connected to PBØ to PB7, respectively, on the 8080 Processor PCB. The remaining lines are connected as follows:

Printer Function	8080 Processor PCB
$\overline{WR}$	PCØ
$\overline{RESET}$	PC3
$\overline{ERROR}$	PC4
$\overline{BUSY}$	PC5
$\overline{LOG\ ON}$	PC6
No Paper	PC7

The PCØ and PC3 lines are outputs from the 8080 Processor PCB to control the printer following the data transfer timing sequence illustrated in Figure 4.21.

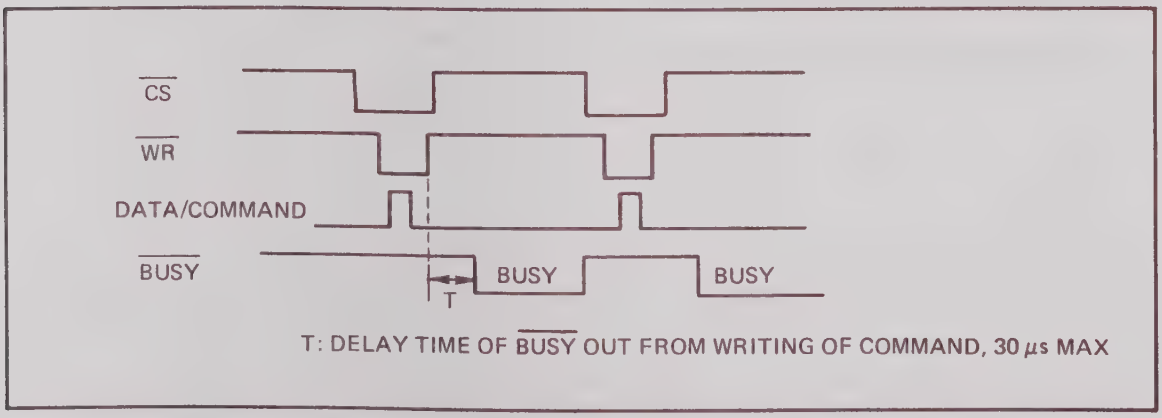


Figure 4.21. Dot Matrix Printer, Timing Sequence for Writing Character Data

The lines PC4 through PC7 are inputs to the 8080 Processor PCB to determine the status of the printer. Transistor Q2 inverts the RESET line from the 8080 Processor PCB to be the correct polarity required by the Control/Drive Card controller. The collector of transistor Q1 will pull LOG ON line function to ground (or to OFF state) whenever power is applied to the printer and the line function senses an open collector or no connection. A leaf-type microswitch (S1) provides the Paper Sense function which is required to protect the print head. The print head can prematurely wear out by attempting to print with no paper to absorb the shock of the printing needles. Components L1, C1, and C2 filter the 3.5 Ampere surge present when the print motor starts and, during operation, smooth the transients generated by the print head solenoids. Connector J3 interfaces both the POWER switch and PAPER ADVANCE switch on the front panel. When the POWER switch is operated to ON, connector pins J3-8, J3-9 are connected to J3-6, J3-7; and J3-4, J3-5 are connected to J3-2, J3-3. Operating the PAPER ADVANCE switch shorts J3-11 to J3-12.

2. Dot Matrix Printer Components

The Star Control/Drive card is equipped with an 8-bit parallel interface and is designed exclusively for the Star Series DP-822 (21 column) dot matrix impact printer. The card includes all drive electronics and control logic, an original Series DPC LSI printer controller chip, print solenoid drivers, motor driver, paper feed solenoid driver, timing signal waveform shaping circuit, and a 6 MHz quartz crystal. The Star DP-series dot matrix printers can be fully controlled by a microcomputer system through its data and control bus. A block diagram of the Control/Drive card is shown in Figure 4.22.

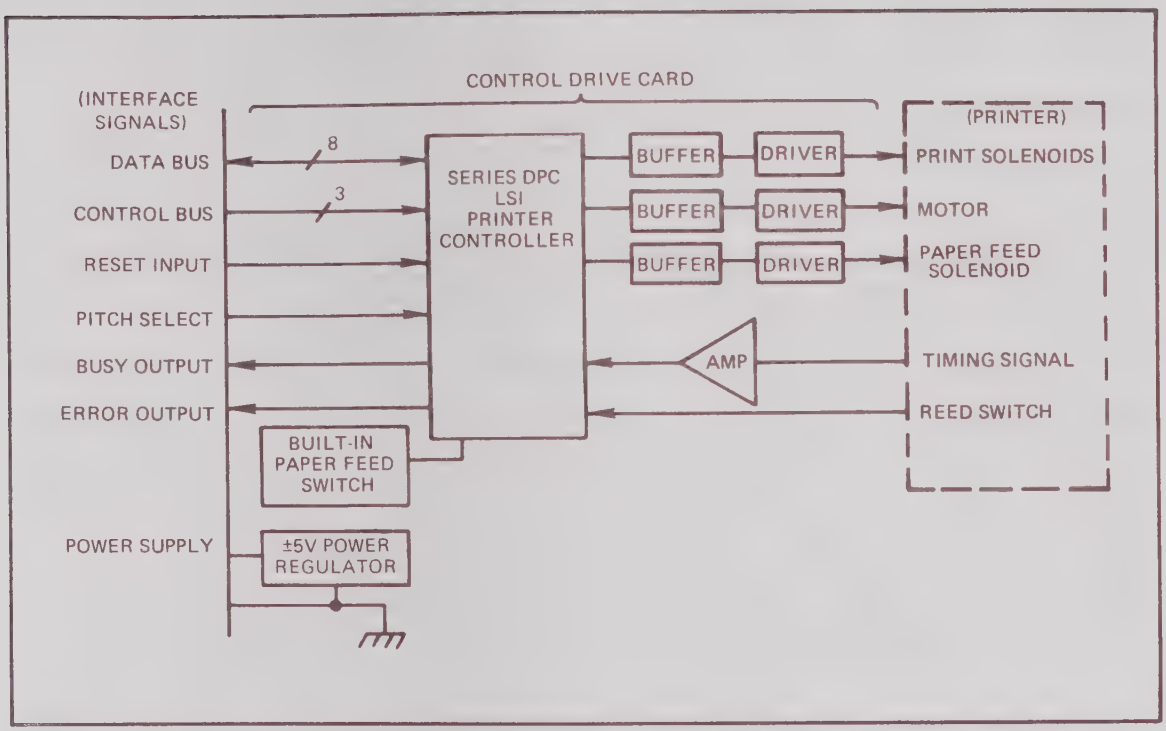


Figure 4.22. Dot Matrix Printer, Control/Drive Card, Block Diagram

Specifications for the Dot Matrix Printer are as follows:

Star Printer Model No.	DP-822-08B
Controller	DPC-1
Marking on LSI	D8041C 534
Character Buffer	21
Character Set	64 ASCII character set and 5 symbols
Pitch Select (columns)	18/21
Power Supply (V dc)	+12 (+10/-5%)
Power Consumption	
Operation (peak)	3.5 Amps
Stand-by (max.)	150 mA
Temperature (Celsius)	
Operating	+5.0° to +40°
Storage	-20 to +70°

Specifications for Dot Matrix Printer (continued)

Humidity (RH in %)	
Operating	30 to 80
Storage (max.)	95 to 40
Dimensions	4 in. x 6-5/16 in. (101 mm x 161 mm)
Interface Connector (CN1)	All inputs TTL compatible

Detailed Characteristics. The following entries provide some detailed characteristics of the dot matrix printer identified as Option Model 4650 for use with the Model 4657. This information is part of the "User's Manual for the Dot Matrix Printer Control/Driver Card" from Star Micronics, Inc., 200 Park Avenue, Pan Am Bldg., Suite 2308, New York, NY, 10166.

a. Controller

The Control/Driver Card incorporates a special LSI controller chip component which provides the following features:

- Microprocessor compatible 8-bit DATA Bus with three device control signal inputs (i.e., $\overline{CS}$, $\overline{RD}$, and $\overline{WR}$); two status output signals (i.e., $\overline{ERROR}$ and $\overline{BUSY}$); and three additional control signal inputs (i.e., $\overline{RESET}$, CP, and $\overline{FSW}$).
- A 5-x-7 matrix character generator for a 64-ASCII character set.
- A one line print buffer (21 characters max.)
- A programmable multiple line feed.
- Off-line test printing capability.
- Machine error detection capability.

b. Discrete Electronics

Components for the following circuits are included:

- Print solenoid driver
- Paper Feed solenoid driver
- Timing signal buffer (or pulse shaping circuitry)
- A +5.0V dc power regulator

c. 6.0 MHz Crystal

A 6.0 MHz quartz crystal is provided on the Control/Drive Card to supply a stable and fast clock timing for the DPC controller circuits.

d. Paper Feed Switch

A paper feed switch is provided on the Control/Drive Card for easy advancing of the paper supply. This switch can also be used for a test printing function.

e. Connectors

Four connectors are provided on the Control/Drive Card. Their general functions and mating connectors are identified in the table below.

Connector	Function	Mating Connector
CN1	Communicating with a microcomputer system	MOLEX 5049-15A
CN2	Connections for power supply, ground, and external paper feed input signal	MOLEX 5049-10A
CN3	Control/Drive Card signals to print head solenoids	UNION MACHINERY L25-014
CN4	Control/Drive Card signals for printer control	(Not applicable)

f. Interfacing

A block diagram showing the relationship of the Control/Drive Card connectors and their functions is shown in Figure 4.23. Connector pinout identification is provided in Table 4.4.

Table 4.4
Dot Matrix Printer,
Control/Drive Card Connector Pinout Identification

CN1

(for communicating with a microcomputer system)

Pin #	Pin Name	Description
1	$\overline{\text{ERROR}}$	Error Output
2	$\overline{\text{BUSY}}$	Busy Output
3	DB7	Data Bus b8
4	DB6	Data Bus b7
5	DB5	Data Bus b6
6	DB6	Data Bus b5
7	DB7	Data Bus b4
8	DB8	Data Bus b3
9	DB9	Data Bus b2
10	CP	Character Pitch Select In
11	DBØ	Data Bus b1
12	$\overline{\text{WR}}$	Write Input
13	$\overline{\text{RESET}}$	Reset Input
14	$\overline{\text{RD}}$	Read Input
15	$\overline{\text{CS}}$	Chip Select Input

CN2

(for power supply & ext. paper feed)

Pin #	Pin Name	Description
1	PFSW (+)	Ext. Paper Feed Switch
2	PFSW (-)	
3	GND	Ground (0V)
4	GND	
5	NC	(+5V out of monitoring)
6	MOTOR GND	Ground for Motor (0V)
7	MOTOR GND	
8	FRAME	Ground for Printer Frame
9	V_{IN}	+12V for 12V dc printers
10	V_{IN}	

Table 4.4 (continued)

CN3

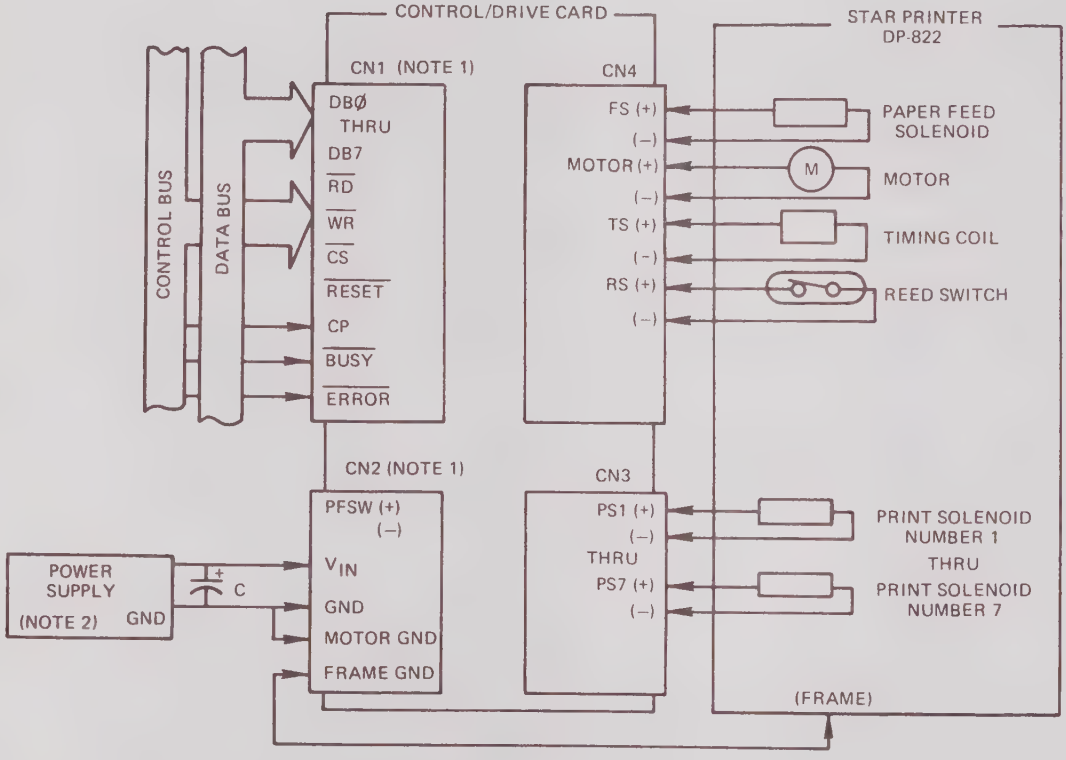
(for print head solenoids)

Pin #	Pin Name	Description
1	PS7 (-)	Print Solenoid for #7 Needle
2	PS7 (+)	
3	PS6 (-)	Print Solenoid for #6 Needle
4	PS6 (+)	
5	PS5 (-)	Print Solenoid for #5 Needle
6	PS5 (+)	
7	PS4 (-)	Print Solenoid for #4 Needle
8	PS4 (+)	
9	PS3 (-)	Print Solenoid for #3 Needle
10	PS3 (+)	
11	PS2 (-)	Print Solenoid for #2 Needle
12	PS2 (+)	
13	PS1 (-)	Print Solenoid for #1 Needle
14	PS1 (+)	

CN4

(for printer control)

Pin #	Pin Name	Description
1	NC	
2	RS (-)	Reed Switch
3	RS (+)	
4	TS (-)	Timing Signal
5	TS (+)	
6	NC	
7	FS (-)	Paper Feed Solenoid
8	FS (+)	
9	MOTOR (-)	Motor
10	MOTOR (+)	



NOTES:
1. CONNECTIONS FOR CONNECTORS CN1 AND CN2 MUST BE WIRED CAREFULLY. REVERSE CURRENT WILL DAMAGE COMPONENTS.
2. POWER SUPPLY REQUIREMENTS:
   VOLTAGE: +12V (+10/–5%)
   CURRENT: 3.5 AMPS PEAK
   CAPACITOR: 10,000 μF RECOMMENDED

Figure 4.23. Dot Matrix Printer, General Interface Functions of the Control/Drive Card Connectors, Block Diagram

g. Mounting Considerations

The nominal dimensions of the Control/Drive Card are shown in Figure 4.24.

h. Operation

The Control/Drive Card is capable of communicating with a microcomputer through the DPC Controller bi-directional 8-bit data bus and device control signals. The device control signals and two status output signals are described in the following paragraphs, and Table 4.5 lists the character coding set that is unique to the operation of the Dot Matrix Printer. (See Figures 4.25 thru 4.28 for component locations, and schematics for the Control/Drive Cards.)

Table 4.5
Dot Matrix Printer, Character Coding Set

				b8	0	0	0	0	0	0	0	0	1	1
				b7	0	0	0	0	1	1	1	1	1	1
				b6	0	0	1	1	0	0	1	1	1	1
b4	b3	b2	b1	col / row	0	1	2	3	4	5	6	7	E	F
0	0	0	0	0			SP	0	@	P				
0	0	0	1	1		DC1	!	1	A	Q				
0	0	1	0	2			"	2	B	R				
0	0	1	1	3			#	3	C	S				
0	1	0	0	4			$	4	D	T				
0	1	0	1	5			%	5	E	U				
0	1	1	0	6			&	6	F	V				
0	1	1	1	7			'	7	G	W				
1	0	0	0	8			(	8	H	X				
1	0	0	1	9			)	9	I	Y				
1	0	1	0	A	LF		*	:	J	Z				
1	0	1	1	B			+	;	K					
1	1	0	0	C			,	<	L					
1	1	0	1	D			-	=	M					
1	1	1	0	E			.	>	N					
1	1	1	1	F			/	?	O	_				

LF = Print/Paper Feed Command
DC1 = Controller Reset Command

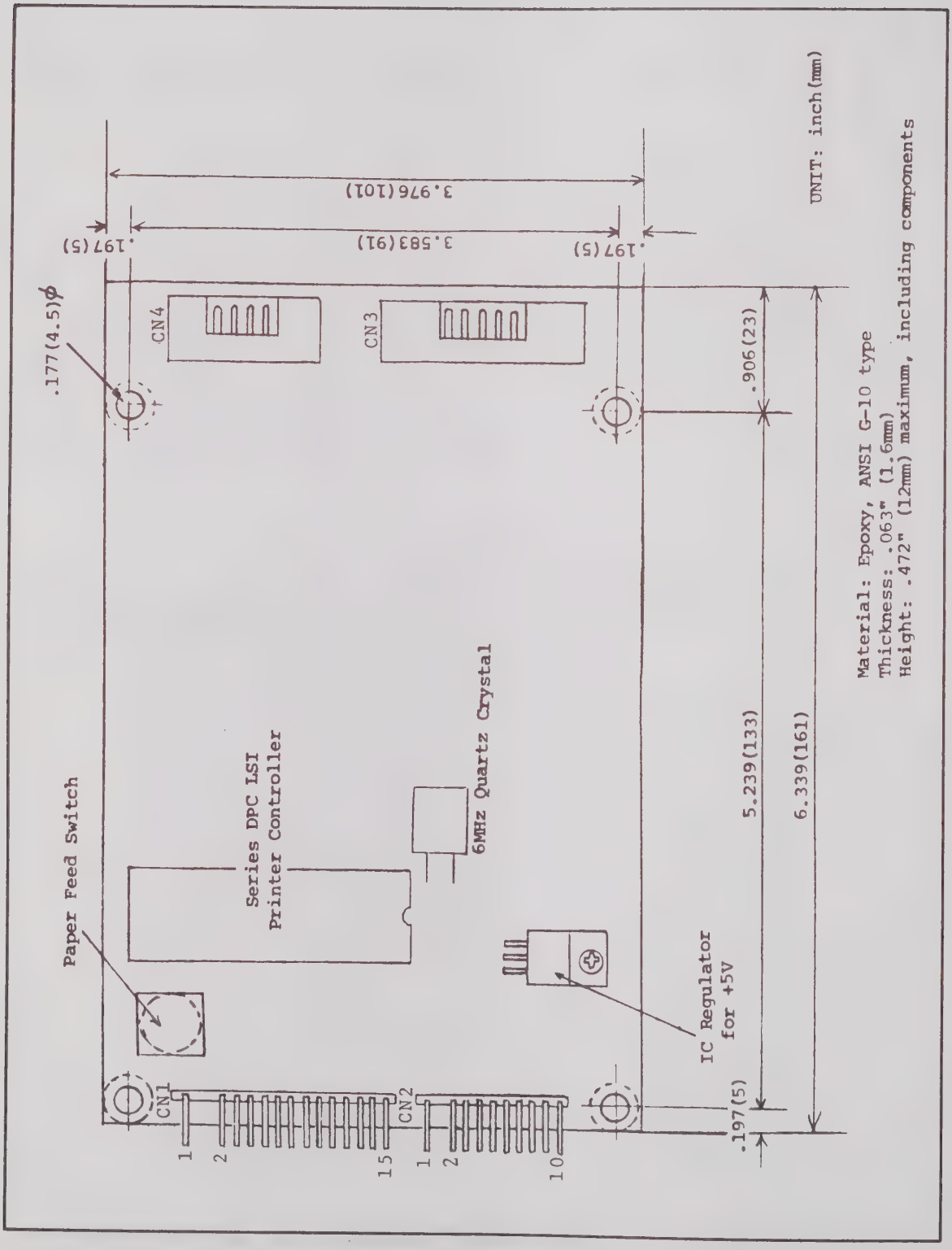


Figure 4.24. Dot Matrix Printer, Dimensions of the Control/Drive Card

h1. Device Control Signals. The operation mode of the Control/Driver Card is selected by shifting the three device control signals as shown below.

$\overline{CS}$	$\overline{WR}$	$\overline{RD}$	Mode	Data Bus
0	0	0	PROHIBITED	character data/command status
0	0	1	WRITE	
0	1	0	READ	
0	1	1	NO OPERATION	
1	x	x	DISABLING	

h2. Reading Status of Data Bus Buffer.

$\overline{CS}$ = 0	DBB:	D7	D6	D5	D4	D3	D2	D1	D0
$\overline{WR}$ = 1		x	x	x	x	x	B	I	x
$\overline{RD}$ = 0									

IBF = Input-Buffer-Full status

BUSY status

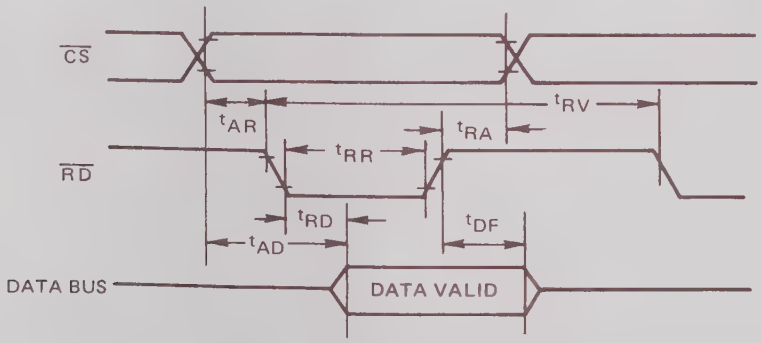
BUSY = 1 Busy
= 0 Not busy = Ready

Busy status is "1" during its processing the data entered or execution of the command. It must be "0" for new entry of data or command.

IFB = 1 Input buffer full
= 0 Input buffer clear

When a character or command is entered, it will be stored in an Input Buffer temporarily making the Input-Buffer-Full status "1". And when the data or command is processed, this IBF status becomes "0". It must be "0" for new entry of data or command.

Timing for Reading Status



DBB Read

SYMBOL	PARAMETER	MIN	MAX	UNIT
t_{AR}	$\overline{CS}$ Setup to $\overline{RD}\downarrow$	0		ns
t_{RA}	$\overline{CS}$ Hold after $\overline{RD}\uparrow$	0		ns
t_{RR}	$\overline{RD}$ Pulse Width	250	5000	ns
t_{AD}	Delay, $\overline{CS}$ to data out		150	ns
t_{RD}	Delay, $\overline{RD}$ to data out		150	ns
t_{DF}	Delay, $\overline{RD}$ to data float	10	100	ns
t_{RV}	Recovery Time between RDs	1		µs

h3. Writing character Data.

$\overline{CS}$ = 0
$\overline{WR}$ = 0
$\overline{RD}$ = 1
BUSY = 0
IBF = 0

DBB:

D7	D6	D5	D4	D3	D2	D1	D0
b8	b7	b6	b5	b4	b3	b2	b1

This character data must be ASCII-coded. Table 2 page 8 shows a character coding set of acceptable ASCII characters and symbols.

h4. Writing Command.

a) Print/Paper Feed Command LF = $0A_H$

$\overline{CS}$ = 0
$\overline{WR}$ = 0
$\overline{RD}$ = 1
BUSY = 0
IBF = 0

DBB:

D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	1	0	1	0

When this command follows the writing of character data, the printer starts to print the data and advances the paper one line. Then the character data will be cleared from the line buffer in the series DPC controller.

If this command is entered without a preceding transfer of data, it is treated as a paper feed command.

Programmable Multiple Line Feed
In addition, if the entry of this command is followed by an entry of data representing a number in binary code, the printer feeds the paper as many lines as programmed by this number.

DBB:

D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	n4	n3	n2	n1	n0

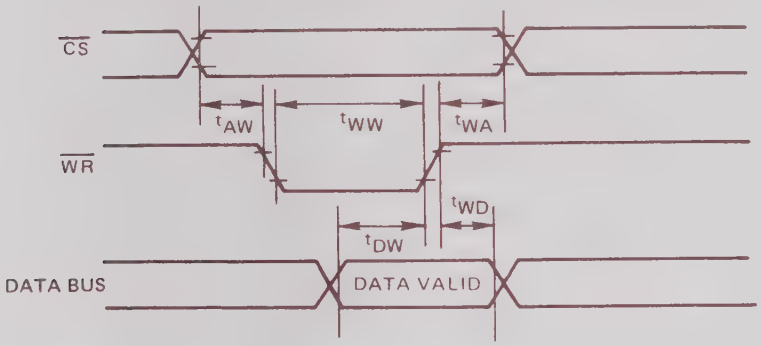
(programmable up to 31 lines)

b) Reset Command DC1 = 11_H

	DBB:	D7	D6	D5	D4	D3	D2	D1	D0
$\overline{CS}$ = 0		0	0	0	0	1	0	1	0
$\overline{WR}$ = 0									
$\overline{RD}$ = 1									
BUSY = 0									
IBF = 0									

When this command is entered, a preceding transfer of character data or command, if any, will be cancelled as well as ERROR output.

Timing for Writing Character Data and Commands



DBB Read

SYMBOL	PARAMETER	MIN	MAX	UNIT
t_{AW}	$\overline{CS}$ Setup to $\overline{WR}$↓	0		ns
t_{WA}	$\overline{CS}$ Hold after $\overline{WR}$↑	0		ns
t_{WW}	$\overline{WR}$ Pulse Width	250	5000	ns
t_{DW}	Data Setup to $\overline{WR}$↑	150		ns
t_{WD}	Data Hold after $\overline{WR}$↑	0		ns

Parts Layout - Model 822-08A

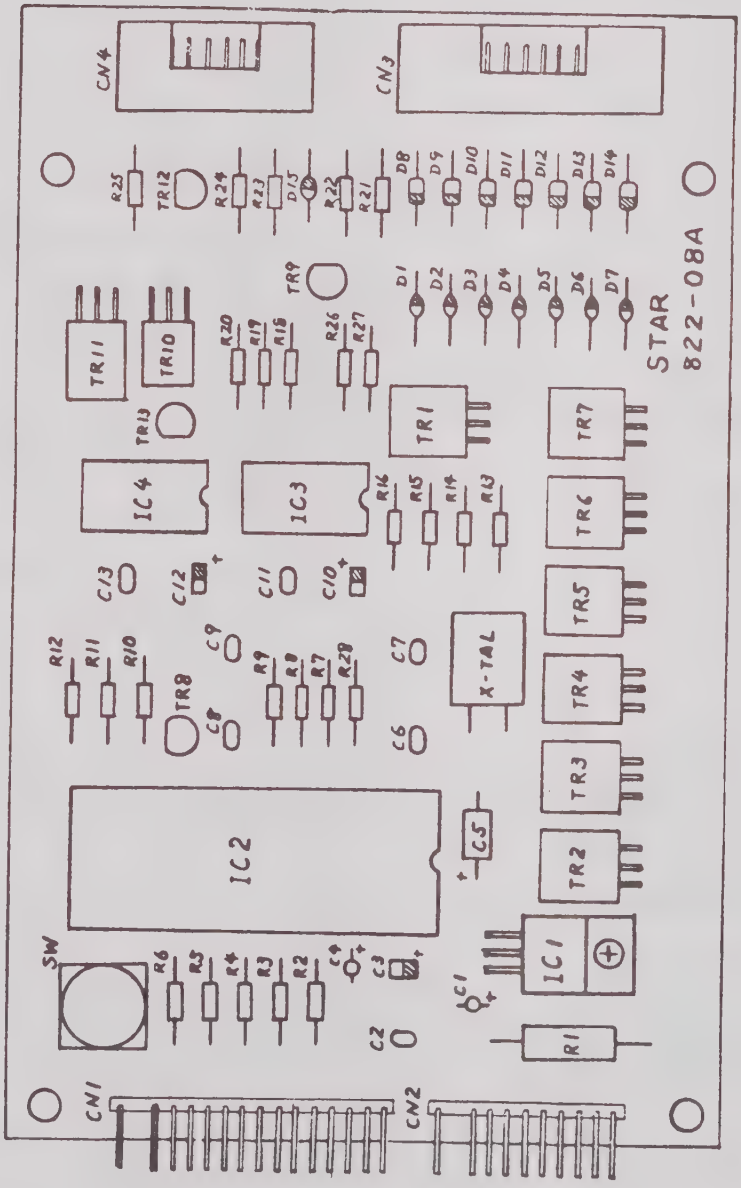


Figure 4.25. Control/Drive Card for Dot Matrix Printer Model 822-08A, Component Location

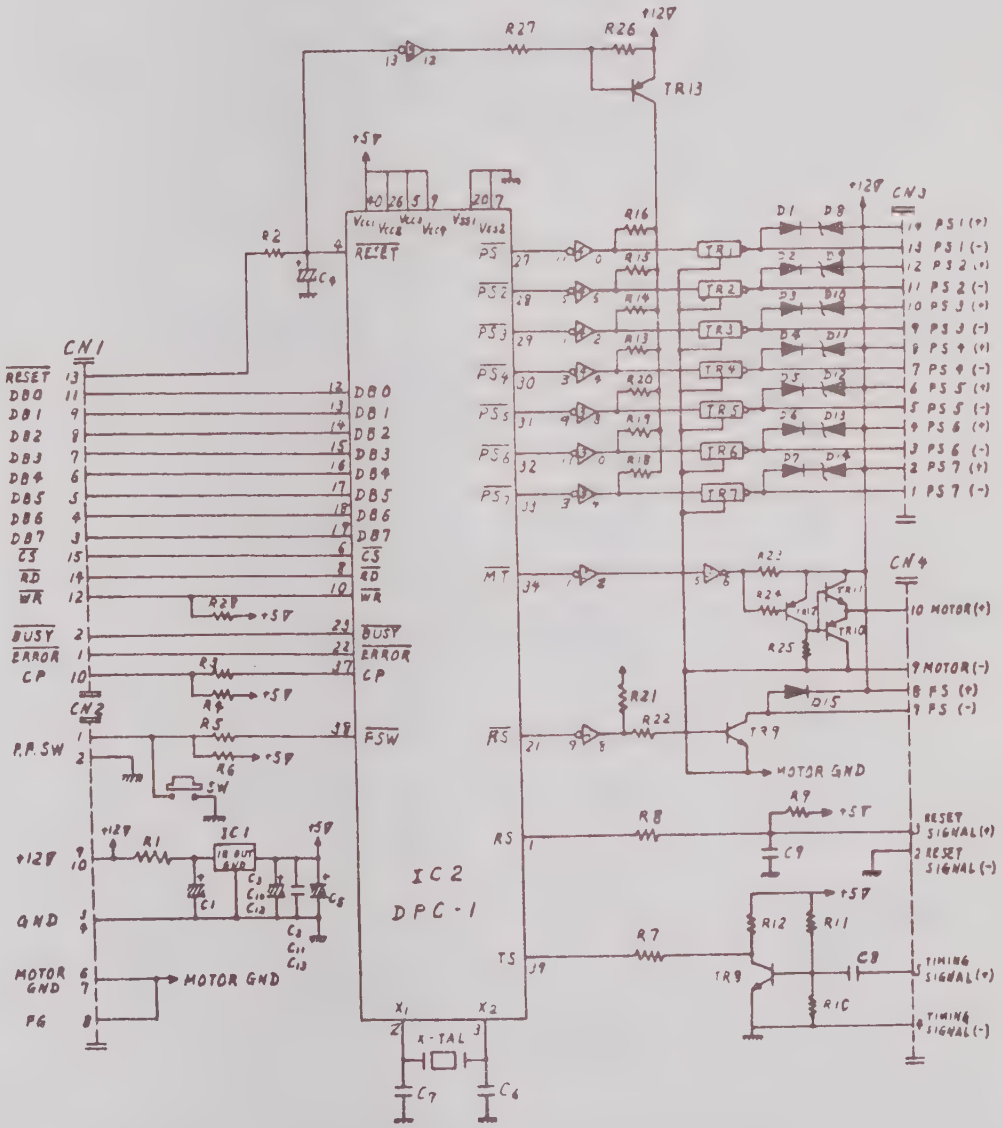


Figure 4.26. Control/Drive Card for Dot Matrix Model 822-08A, Schematic Diagram

Parts List of Control/Drive Card for Model 822-08A

Type of Component	Star Part Number	Description	Qty.	Mfr's Number or Characteristics	Supplier
P.C. Board		Two-sided	1	822-08A	
IC	IC2	LSI, custom	1	DPC-1	NEC
	IC1	Constant voltage	1	μPC14305H	NEC
	IC3,IC4	TTL	2	SN7406	TI
Transistor	TR1-TR7	Power darlington	7	2SD558	NEC
	TR8		1	2SC945 (Q)	NEC
	TR9		1	2SC2001 (L)	NEC
	TR10		1	2SB564 (L)	NEC
	TR11		1	2SC1449 (L)	NEC
	TR12,TR13		2	2SA733 (Q)	NEC
Diode	D1-D7,D15		8	F-14A	NEC
	D8-D14	Zenor	7	RD-6.2F	NEC
Resistor	R1	solid	1	(watts) (ohms) 2W ±10%, 22 ohms	
	R2,R3,R5,R7 R8,R13-R16 R18-R20,R22	carbon	13	1/4W =5%, 1K	
	R4,R6,R11,R28	carbon	4	1/4W ±5%, 120K	
	R9	carbon	1	1/4W ±5%, 4.7K	
	R10	carbon	1	1/4W ±5%, 22K	
	R12,R23	carbon	2	1/4W ±5%, 10K	
	R21,R24	carbon	2	1/4W ±5%, 2.2K	
	R25	carbon	1	1/4W ±5%, 470	
	R26	carbon	1	1/4W ±5%, 560	
	R27	carbon	1	1/4W ±5%, 5.6K	
Crystal	X-TAL	6 MHz	1	HC-18U	YAGUMO TSUSHIN
Condensor	C1,C4	Tantalum	2	3.3 μF, 16V	NEC
	C2,C11,C13	Ceramic	3	0.022 μF, 50V	
	C3,C10,C12	Tantalum	3	UBD10W223K 6.8 μF	TAIYO YUDEN
	C5	Aluminum	1	CS99E1D6R8M 47 μF, 10V	NEC
	C6,C7	Ceramic	2	10ELA47T 20pF	NICHICON
	C8,C9	Ceramic	2	DT200YB20PF 0.1 μF, 12V	NICHICON
				BD10X104X	TAIYO YUDEN
Switch	SW	Push Button	1	AKC8N	ALPS ELECTRIC
Connector	CN1		1	5049-15A	MOLEX
	CN2		1	5049-10A	MOLEX
	CN3		1	L25-014	UNION MACHINERY
	CN4		1	L25-010	UNION MACHINERY
Cable		with connectors for CN1 and CN2	1 set		

Parts Layout - Model 822-08B-12

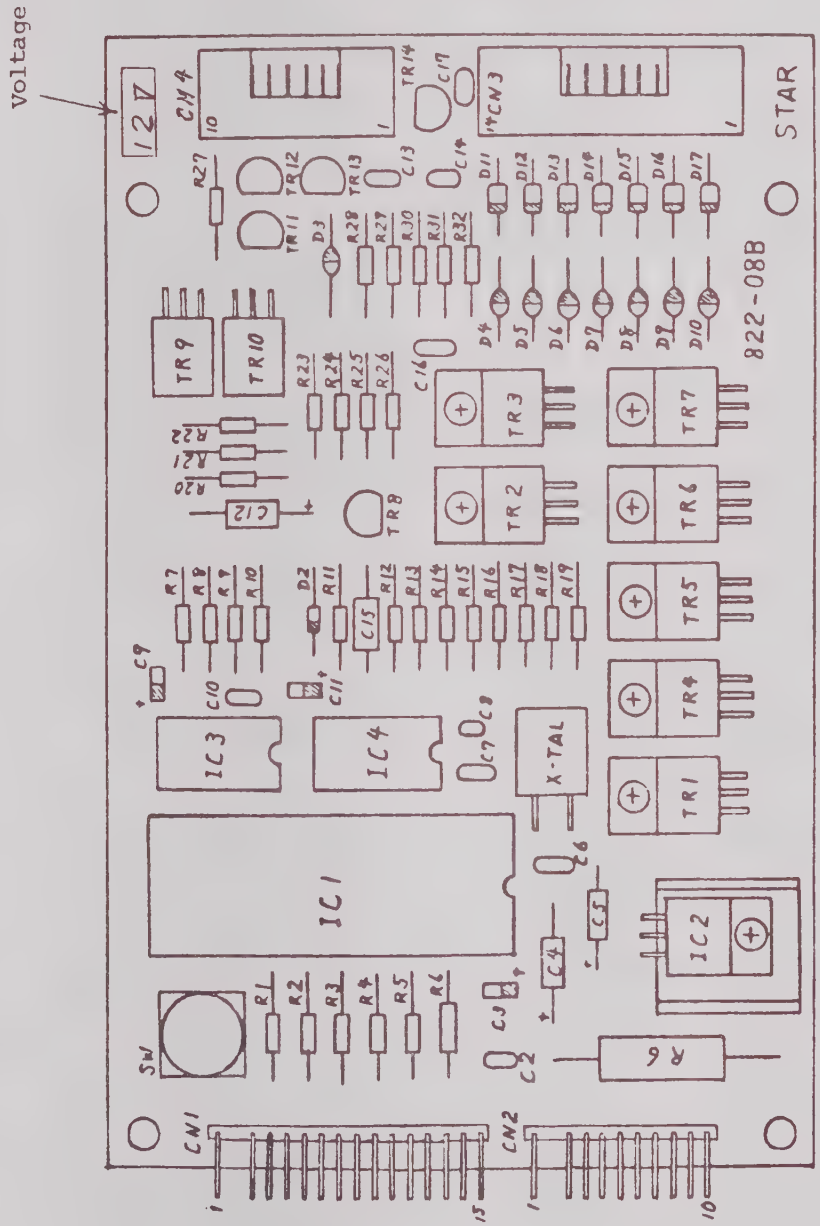


Figure 4.27. Control/Drive Card for Dot Matrix Printer Model 822-08B, Component Location

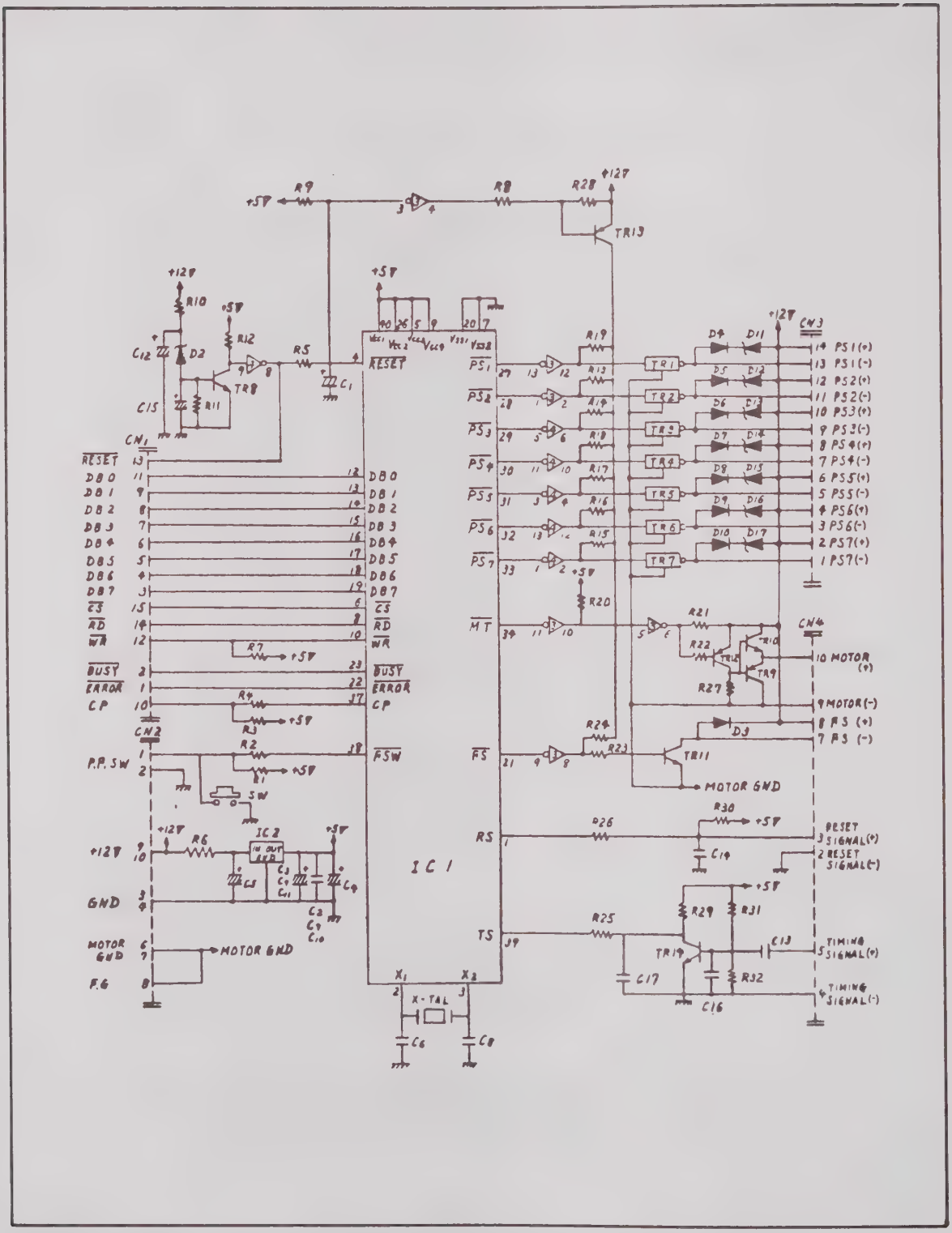


Figure 4.28. Control/Drive Card for Dot Matrix Model 822-08B, Schematic Diagram

Parts List of Control/Drive Card for Model 822-08B

Type of Component	Star Part Number	Description	Qty.	Mfr's Number or Characteristics	Supplier
P.C. Board		Two-sided	1	822-08B	
IC	IC1	LSI, custom	1	DPC-1	NEC
	IC2	Constant voltage	1	μPC14305H	NEC
	IC3,IC4	TTL	2	SN7406	TI
Transistor	TR1-TR7	Power darlington	7	2SD686	TOSHIBA
	TR8,TR14		2	2SC945 (Q)	NEC
	TR9		1	MJE700	MOTOROLA
	TR10		1	2SC1449 (L)	NEC
	TR11		1	2SC2120 (O)	TOSHIBA
	TR12,TR13		2	2SA733 (Q)	TOSHIBA
Diode	D2	Zener	1	HZ9C-2L	HITACHI
	D3-D10		8	F-14A	NEC
	D11-D17	Zener	7	RD-6.2F	NEC
Resistor	R1,R3,R7,R31	carbon	4	(watts) (ohms) 1/4W ±5%, 120K	
	R2,R4,R5,R23 R25,R26	carbon	6	1/4W ±5%, 1K	
	R6	carbon	1	2W ±5%, 22	
	R8	carbon	1	1/4W ±5%, 5.6K	
	R9	carbon	1	1/4W ±5%, 220K	
	R10,R11,R21 R29	carbon	4	1/4W ±5%, 10K	
	R12,R20,R30	carbon	3	1/4W ±5%, 4.7K	
	R13-R19,R22 R24,R27	carbon	10	1/4W ±5%, 2.2K	
	R28	carbon	1	1/4W ±5%, 560	
	R32	carbon	1	1/4W ±5%, 22K	
Crystal	X-TAL	6 MHz	1	HC-18U	YAGUMO TSUSHIN
Condensor	C1	Aluminum	1	3.3 μF, 50V TY(MS) type	NEC
	C2,C7,C10	Ceramic	3	0.022 μF, 50V UBD10W223K	TAIYO YUDEN
	C3,C9,C11	Tantalum	3	6.8 μF CS99E1D6R8M	NEC
	C4	Aluminum	1	47 μF, 6.3V TT(MS) type	SHIN'EI TSUSHIN
	C5,C15	Aluminum	2	1 μF, 50V TT(MS) type	SHIN'EI TSUSHIN
	C6,C8	Ceramic	2	20pF DT200YB20PF	NICHICON
	C12	Aluminum	1	10 μF, 35V TT(MS) type	SHIN'EI TSUSHIN
	C13,C14	Ceramic	2	0.1 μF, 12V BD10X104X	TAIYO YUDEN
Switch	SW	Push Button	1	AKC8N	ALPS ELECTRIC
Connector	CN1		1	5049-15A	MOLEX
	CN2		1	5049-10A	MOLEX
	CN3		1	L25-014	UNION MACHINERY
	CN4		1	L25-010	UNION MACHINERY
Screw & Nut		Screw	1	TR3-7	
		Screw	7	TR3-5	
		Nut	8	N-3	
Heat Sink		Aluminum plate	1		
Cable		with connectors for CN1 and CN2	1 set		

4.5 OPERATIONAL PROGRAMS

A. General

The operational program for the Model 4657 Error Rate Analyzer resides in 32K bytes of EPROM memory and uses 4K bytes of RAM. The Real-Time Clock PCB (A10) provides sockets for two 2764-type EPROMs which represent 16K bytes of memory, and one 6116 CMOS RAM with battery back-up for 2K of nonvolatile storage. The 8080 Processor PCB (A9) provides sockets for two 2764-type EPROMs which represent 16K bytes of memory, and one 6116 which provides 2K bytes of RAM. The program was written in a logical combination of FORTRAN and 8080 Assembly language. Also, the program was written in a highly modular form using structured programming techniques. Various routines and subroutines were connected through branch tables and linked using a linking loader. A floating point package tailored to this application provides the math capability required in normal BERTS operation.

B. Routine

The interface driver routines required for the Printer option (Model 4650) are supplied in ROM of all Model 4657 Analyzers. An extra EPROM which contains routines for the IEEE-488 and RS-232C Interfaces is provided with these options. During the Power-Up interval, the initialization routines determine which option is installed and which driver routines to call during operation.

The Model 4657 Analyzer is of a software intensive design. The error counting hardware provides status lines, million bit interrupts, and three "wrap-around" error counters for Bit, Parity, and Bipolar Violations. The program from these functions develops the Error Seconds, Total Errors, Average BER, and formats the displays and print-out messages. "Wrap-around" counter lengths are 12 bits for Bit Error, 8 bits for Parity Error, and 12 bits for Bipolar Violations.

The software services the million-bit interrupt every 22 milliseconds by reading the error counters and adding any increases to internal software accumulators. Each accumulator is 40 bits long. The length of a hardware "wrap-around" counter determines the maximum error rate that can be counted since each will be read every million bits. For Bit and Bipolar Violation errors, this is equal to $2^{12}/10^6$ (or BER = 4×10^{-3}). Since there can be only 210 Parity errors per million bits, all Parity errors can be counted with an 8-bit hardware counter. The software counts ten interrupts to provide the latest BER on a 0.22-second update rate or 100 million-bit interrupts for a 2.2-second update.

To measure Error-Seconds, all errors are related to the 1.0-second interrupts from the Real-Time Clock in asynchronous error-second mode. Average BER is then calculated by counting million-bit interrupts during the length of the test and dividing total errors by total 1.0-second pulses. Because errors are counted over million-bit intervals and at 44.736 Mbps, there will not always be the same number of million-bit intervals in each 1.0-second short timed test. (The 1.0-second timed test is only an example of a back-to-back test with a compatible Model 4651A BERTS Transmitter set for a high error rate.) The total errors will vary between two numbers from second to second corresponding to counting either 44 or 45 million-bit interrupts.

Since BER is computed on the number of million-bit interrupts, Average (AVG) BER will always be correct, TOTAL ERRORS will be correct, and ERROR-SECONDS will be correct to within the quantization interval. Quantitizing errors to million-bit intervals simplifies calculations for various displays. For example, the microprocessor cannot operate nor calculate on errors at 44 Mbps, but through the quantitizing process, data can be supplied to the microprocessor at a rate within its design parameters.

C. Memory and I/O Assignments

The operational program for the Model 4657 resides in ROM address location ØØØØH to 7FFFH. RAM is located in D8ØØH to FFFFH. The basic I/O assignments are listed in Table 4.6.

Table 4.6
Model 4657 Analyzer,
Operational Program I/O Assignments

Hardware	Port Instruction	Address	Operation
Error Counter 1 and External Event Monitor	Input	DØH or D8H	Input low order 8-bits of Bit Error Counter and clear 10^6 Interrupt.
	Input	D1H or D9H	Input both high order 4-bits of Bit Error Counter and Million-Bit Interrupt Status.
	Input	D2H or DAH	Resets Digit Counter U21
	Input	D3H or DBH	Increments Digit Counter U21
	Input	D4H or DCH	Input data byte from ADC latch U22
	Input	D5H or DDH	Input strobe status bit from U20
	Input	D6H, D7H, DEH, DFH	Decoded but Not Used
Real-Time Clock	Input/Output	4ØH	Milliseconds counter, BCD (Top 4 bits)
	Input/Output	41H	Tenths and Hundredths of Seconds, BCD
	Input/Output	42H	Seconds, BCD
	Input/Output	43H	Minutes, BCD
	Input/Output	44H	Hours, BCD
	Input/Output	45H	Day of the Week, BCD
	Input/Output	46H	Day of the Month, BCD
	Input/Output	47H	Months, BCD
	Output	48H	Milliseconds comparison latch
	Output	49H	Tenths and hundredths of seconds comparison latch
	Output	4AH	Seconds comparison latch
	Output	4BH	Minutes comparison latch
	Output	4CH	Hours comparison latch
	Output	4DH	Day of the week comparison latch
	Output	4EH	Day of the month comparison latch
	Output	4FH	Months comparison latch
	Input	5ØH	Interrupt Status
	Output	51H	Interrupt Control
	Output	52H	Counter Reset
	Output	53H	Latch Reset
	Input	54H	Status Bit
	Output	55H	"GO" command

Table 4.6 - continued

Hardware	Instruction	Port Address	Operation
Real-Time Clock continued	Output	56H	Standby Interrupt
	Output	58,59	Number of Burst
	Output	5A,5B	Length of Last Burst
	Output	5FH	Test mode
Front Panel I/O	Input/Output	7ØH	8279 Data, Read Switch Address or Write Display
	Input/Output	71H	8279 Data, Control Register
	Output	72H or 73H	Octal Latch U16: controls discrete LEDs.
	Output	74H or 75H	Octal Latch U17: controls discrete LEDs.
Error Control 2 & 3	Input	9ØH	Read low order 8-bits of Bipolar Violation Counter
	Input	91H	Read high order 4-bits of Bipolar Violation Counter
	Input	92H	Read 8-bits of Parity Error
	Input	93H	Read STATUS Lines: SIGNAL LOSS, FRAME LOSS, BLUE SIGNAL, PRBS LOSS, and BAND RATE
	Output	94H	Output to Select Error Output for front panel connector and Select DSX-3 Compensation
RS-232 Interface	Input/Output	8ØH/82H	8251A USART; DATA
	Input/Output	81H/83H	8251A USART; COMMAND/STATUS
	Input/Output	84H	8253: COUNTER Ø
	Input/Output	85H	8253: COUNTER 1
	Input/Output	86H	8253: COUNTER 2
	Input/Output	87H	8253: COMMAND/STATUS
	Output	88H/8BH	8253: COUNTER 2 CLOCK
IEEE-488 Interface	Input/Output	AØH	Interrupt Status and Mask
	Input/Output	A1H	Command Status Register
	Input/Output	A2H	Address Mode
	Input/Output	A3H	Auxiliary Command
	Input/Output	A4H	Address Register
	Input/Output	A5H	Serial Poll Register
	Input/Output	A6H	Parallel Poll Register
	Input/Output	A7H	Data Register
8080 Processor PCB (A10) - Printer I/O	Input/Output	EØH*	8255A: Port A
	Input/Output	E1H	8255A: Port B
	Input/Output	E2H	8255A: Port C
	Input/Output	E3H	CONTROL REGISTER
			*REDUNDANT EØ-FFH

D. Hardware/Software Interfacing

There are six sources of interrupts to the microprocessor. They are identified as:

1. Million-bit interrupt
2. One-second pulse from the Real-Time Clock
3. One tenth second pulse from the Real-Time Clock
4. Burst interrupt
5. Power failure
6. Option installed (either RS-232 or IEEE-488)

When interrupted, the software first checks if the "million-bit interrupt" is active by testing for a Ø in bit 4 of Address DlH. This interrupt will be reset by Address DØH. The next check is made of the 1.0-second pulse interrupt by testing for a Ø in bit 7 of Address 4ØH, which will be reset by Address 41H. The "front panel switch active" interrupt is serviced through the command register and Address 71H to the Front Panel Interface PCB through the 8279 programmable Keyboard Display Interface component. The "option interrupt" (if installed) will be processed by inputting or outputting data as determined by an interrupt register provided in the Controller circuit of the installed option PCB.

E. Printer Driver

The local Printer (Option Model 4650) receives data from a parallel I/O port on the 8080 Processor PCB (A10). The data is output as ASCII format with software generated READ, WRITE, and STROBE LINES. Input data consists of printer OFF (or disconnected) and Out-of-Paper from the paper sense switch. Messages are formatted identical to operation with the RS-232C Interface Option (257190) PCB; but the data is separately buffered so that the difference in speed between a local Printer and an RS-232C Interface output (for example) will not slow down the faster device.

CHAPTER 5
MAINTENANCE

5.1 GENERAL

Due to the reliability and nature of the Model 4657 Analyzer, periodic maintenance is not necessary beyond keeping the air intake filters clean. It is recommended, however, that units be inspected and calibrated yearly by Scientific-Atlanta personnel or representatives. This action will insure that the equipment will meet all published specifications and provide the user with trouble free, accurate performance. The nearest Scientific-Atlanta Regional Service Center can arrange for such factory calibration. These centers are listed on the last page of this chapter.

WARNING

MAINTENANCE OR SERVICE TO THIS EQUIPMENT MUST BE PERFORMED ONLY BY TRAINED SERVICE PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED, SUCH AS FIRE AND ELECTRICAL SHOCK. WHEN SERVICE CAN BE PERFORMED WITHOUT POWER APPLIED, REMOVE ALL POWER.

UPON COMPLETION OF SERVICING, BE SURE THAT ALL SAFETY FEATURES ARE INTACT AND FUNCTIONING AND THAT PROTECTIVE GROUNDING HAS BEEN CONNECTED.

5.2 TROUBLESHOOTING

The intent of this section is to enable the technician to repair equipment out of warranty by locating and identifying defective printed circuit boards. Once the defective printed circuit board has been isolated, either a pre-tested replacement may be obtained from Scientific-Atlanta or further troubleshooting may be performed. It is suggested that prior to troubleshooting within a printed circuit board, the technician review thoroughly the applicable section in the Theory of Operation, Chapter 4, and the appropriate schematic.

Signals received by and generated internally to the Model 4657 Analyzer are processed centrally by the microcomputer on the 8080 processor PCB (A10) which controls functions such as routing and distribution through other various printed circuit boards. While it is not possible to describe all the failure modes associated with a Model 4657 Analyzer operating into a system, there are basic steps which can be performed to locate and isolate malfunctions. This chapter is arranged to provide a logical sequence of basic procedures to isolate a fault within a Model 4657 Analyzer.

5.3 TROUBLESHOOTING THE MODEL 4657 ANALYZER

The following tests should be performed and verified using a Hewlett-Packard Model 3465A Digital Volt Meter (DVM) for voltage and resistance measurements and a Tektronix Model 475 Oscilloscope to observe waveform patterns. The test equipment should be calibrated and operating within its specified accuracy. Equivalent or better test equipment may be substituted when required.

Figure 5.1 is a flow chart of step-test sequences to isolate a malfunction within a Model 4657 Analyzer. Obviously the malfunction symptoms will dictate which steps should be performed and which steps can be set aside as secondary or to be performed if the initial steps fail to isolate the malfunction. If a malfunction is isolated to a printed circuit board which can be field calibrated (i.e., a power source PCB), perform the entire calibration procedure before attempting to verify normal operation. If a malfunction is isolated to a source that is not field repairable (i.e., 8080 Processor PCB (A10) et. al.) and/or does not respond to normal repair procedures and/or calibration, then the suspect source should be replaced by an identical item purchased from Scientific-Atlanta.

A. Model 4657 Analyzer Visual Inspection

A visual inspection check of a Model 4657 Analyzer should consist of the following steps as a minimum:

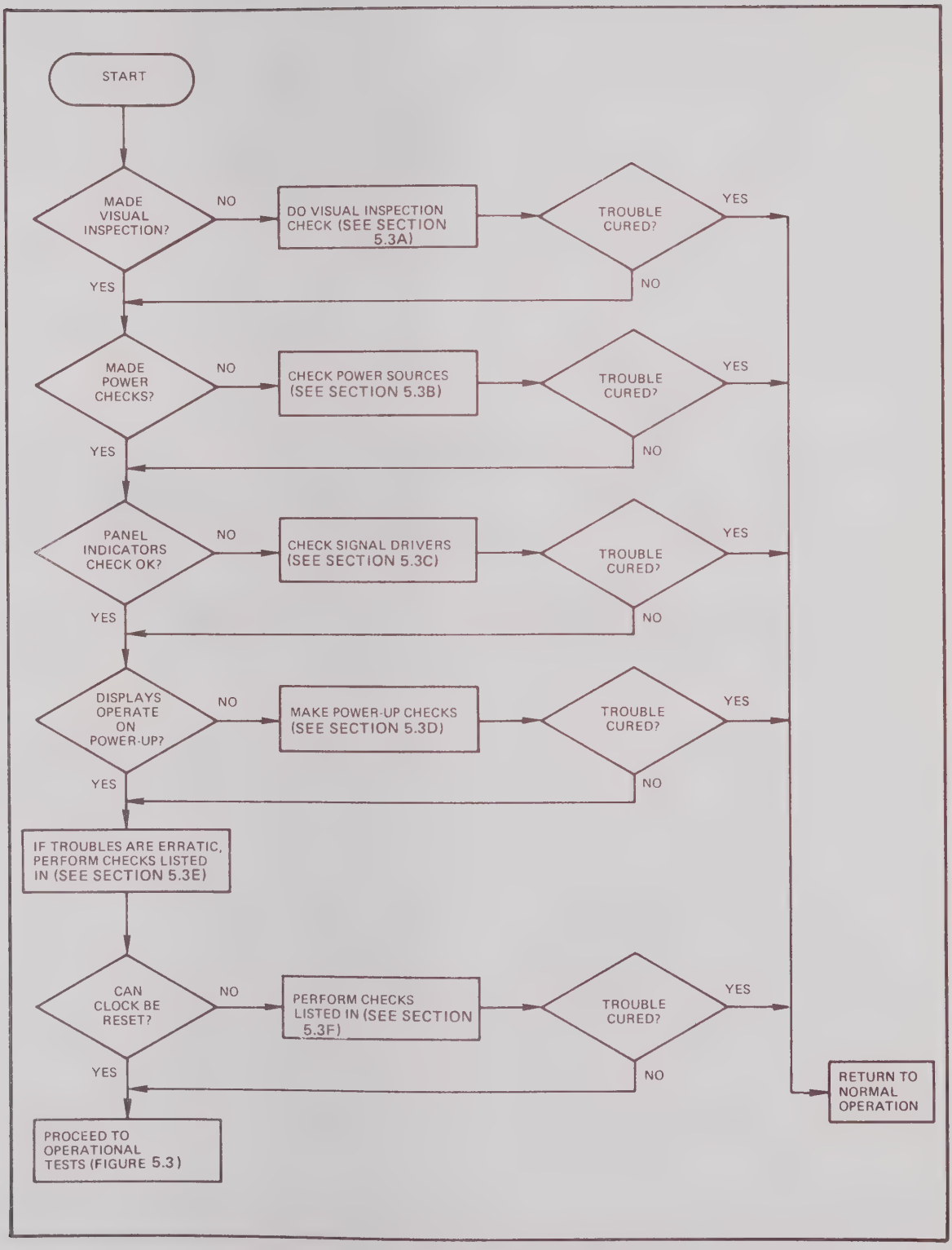


Figure 5.1. Troubleshooting Flow Chart

- Check all PCB's for proper installation and location.

- Check for broken wires. This includes all PCB connections, coax and flat cables, and panel connections. Examine PCB components for obvious defects (i.e., discoloration, bulging, overheating, etc.).

- Check that all cables are properly installed. Use Figure 7.1 for reference. Also inspect for bent pins, discolored or deformed connector shells, frayed or punctured insulation, etc.

B. Model 4657 Analyzer Power Sources

A check of the Model 4657 Analyzer power sources should be verified using the DVM and the following tests:

- Check the AC source (if used). Determine if the ac source is controlled by a switch. Check the source ac at the chassis connector. Verify that the voltage select PCB next to the ac fuse is properly installed. (See Figure 5.2.) Check the ac fuse for continuity. Check ac distribution using schematic diagrams in Chapter 7.

- Check the DC Input source (if used). Determine if the dc source is connected using the correct polarity. Check the dc fuses on the Rectifier and Filter Assembly PCB (A15A1) for continuity. Check the input dc source distribution using schematic diagrams in Chapter 7.

- Check the operation of the -5.2V/-12V Power Supply PCB (A12) and the +5.0V/+12V Power Supply PCB (A13). This can be done rapidly by carefully removing the 44.7 MHz Clock Recovery PCB (A1). Insert the extender card into the slot location A1 connector and verify the following requirements. If the requirements are not met, troubleshoot the power supply PCB.

  On the card extender, measure from pin E to pin P.

  Requirement: -12(±0.4)V dc

  On the card extender, measure from pin E to pin K.

  Requirement: -5.2(±0.3)V dc

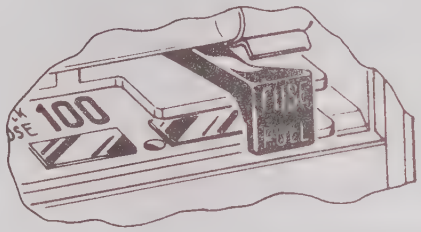
  On the card extender, measure from pin E to pin C.

  Requirement: +5.0(±0.25)V dc

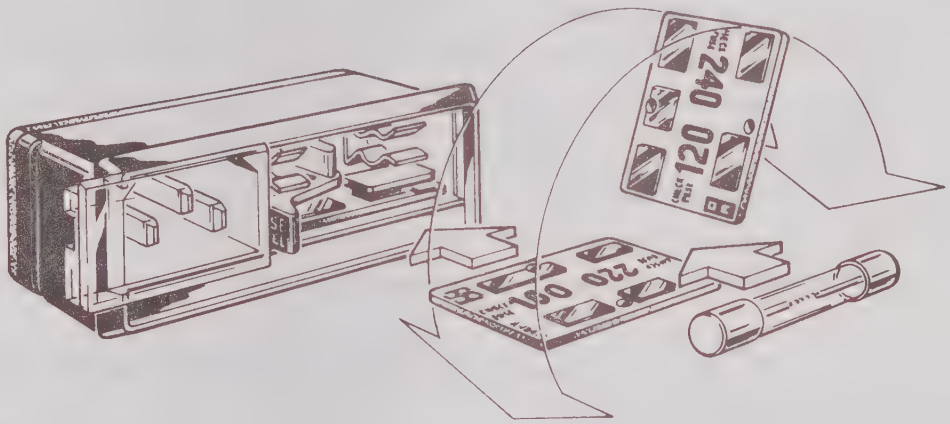
  On the card extender, measure from pin E to pin N.

  Requirement: +12.0(±0.4)V dc

NOTE: After the requirements are verified and before the next tests, remove the card extender and return the 44.7 MHz Clock Recovery PCB (A1) to its original position.



Operating voltage is shown through the sliding plastic window.



HOW TO SELECT OPERATING VOLTAGE

1. Remove the ac power cord connector.
2. Slide the plastic window to the left.
3. Carefully operate FUSE PULL tab to the left.
4. Carefully remove both the fuse and printed circuit board. A small hole is provided to accommodate a wire pull if necessary.
5. Correctly orient the printed circuit board so the desired voltage is located on the top left side.
6. Carefully return the printed circuit board to the original location. Be sure it is securely seated.
7. Return FUSE PULL tab to the normal position.
8. Replace the original fuse with one selected for correct fuse value.

Illustrations courtesy of Corcom Corp., Chicago, Ill.

Figure 5.2. Selecting the Proper Operating Voltage

C. Model 4657 Analyzer Panel Indicators

A check to verify that the Model 4657 Analyzer front panel indicators are properly conditioned is provided in the following tests. Remember that the front panel LEDs are multiplexed using a clock signal from the 8080 Processor PCB (A10).

- Verify that the 8080 Processor PCB (A9) is providing a 1.8 MHz clock signal at pin c. (Using the extender card for this test is recommended.) Return equipment to original condition after testing.
- Thoroughly inspect the 50-conductor flat cable connecting to the Front Panel PCB (A14A3). Test for open conductors and/or high resistance connections. Figure 7.46 is the cable schematic.
- Check for proper installation of the Front Panel Interface PCB (A14A3) to the front panel. Observe for bent connector pins and/or misalignment of the PCB that could allow a short circuit or other types of signal malfunctions.

D. Model 4657 Analyzer Power-Up Checks

With proper AC/DC source input voltage applied, and with the Power switch ON, observe the following steps:

1. "OPT" will appear in the TIME display indicating that Options are being searched for. Routines for options found will be linked into the program.
2. Either an "A" or an "S" will appear in the fourth position of the TIME display indicating the selection of either Asynchronous or Synchronous Error Seconds.
3. A Hexadecimal number will appear in the fifth position of the TIME display for each option found indicating the 8K boundary address at which the Option Routines reside.
4. Each option will display its own Sign-on message in the sixth and seventh positions of the TIME display and in the MEASUREMENT display. (See the appropriate option section of the Operator's Manual.)
5. A LAMP TEST will be executed during which the RESET switch can be pressed if a PRISTINE RESET is desired.

6. Operation will resume in the state the Model 4657 Analyzer was in at time of POWER-DOWN (or in the default state if a PRISTINE RESET was performed) with the RUN or STOP LED flashing to indicate POWER LOSS. The non-volatile RAM in the Model 4657 Analyzer enables the unit to "remember" its state prior to power down.

The displays will not illuminate unless there is a proper AC/DC source input applied. The battery backup provides the Real-Time Clock PCB (A9) with sufficient power to keep current time and date information only. If the TIME display is erratic, the battery may be fully discharged. The battery will normally recharge while the equipment is provided external source power. If the TIME display does not start a running count within ten minutes (supposing the battery was completely discharged), use a DVM to measure the battery voltage. A running TIME display should be observed if the battery voltage is over 3.0V dc, and battery voltage could measure approximately 4.0V dc while being charged. If the charging voltage does not exceed 3.0V dc, the battery should be replaced. It should be noted that the Model 4657 Analyzer can operate without the battery, but each Power-Up sequence will require the TIME display to be reset.

E. Model 4657 Analyzer Self-Test

The Model 4657 Analyzer has the capability to test some of its own hardware. The attempt to enter a negative value for MONTH-DAY while in the STOP mode puts the Model 4657 Analyzer into a nondestructive (no information is lost) SELF-TEST. The simplest way to access this mode is to press the ELAPSED (±) switch and then the MONTH-DAY switch with the SHIFT switch held in. The message "tESt" will then appear in the TIME display. The Real-Time Clock will be tested, RAM (Random Access Read/Write Memory) and ROM (Read Only Memory) will then be tested and the results will be shown in the MEASUREMENT display. Next, the Scientific-Atlanta program firmware number will be displayed, the firmware revision level, the audible alarm will be sounded, and a LAMP TEST will be initiated. Note that the RESET button may be pressed during this LAMP TEST if a PRISTINE RESET is desired. Also note the following:

- RAM and ROM reside on two separate boards: the Central Processor Unit Board (CPU) and the Real-Time Clock Board.

- The SELF-TEST displays the location of the first RAM and ROM chip in which it detects a failure only.

- A failure does not necessarily indicate a defective chip. The failure could be due to solder bridges on either of the two cards, or an improperly seated Motherboard card.

F. Model 4657 Analyzer Real-Time Clock Reset

The Model 4657 Analyzer Real-Time Clock display is a prominent feature and often is the first indication of equipment malfunction. The following tests should be performed if resetting the TIME display presents a problem.

- If the time and date are inaccurate on power-up, it is possible that the battery has discharged. Check it for +5V dc and replace if necessary.

- Use the oscilloscope and test the Bus Decoders (A10U15 and A10U16) on the Real-Time Clock PCB (A9). Replace if necessary.

5.4 MODEL 4657 ANALYZER OPERATIONAL TESTS

There will be times when the fastest method of identifying Model 4657 Analyzer malfunctions and the isolation of a fault is to inject a valid data signal and observe the resulting indications. The sequence as shown in Figure 5.3 and used in the following procedures provides interpretation of some common failures with suggested diagnostic steps to rapidly isolate a malfunction. The term "valid DS3 signal" used in the following procedures should be understood as a signal such as generated and output from a Model 4651A BERTS Transmitter known to be operating within its specified range and accuracy. An equivalent signal may be substituted if available.

A. Signal Loss Failure

If the Model 4657 Analyzer indicates normal operation (i.e., no faults as identified in Section 5.3) but applying a valid DS3 signal input causes the SIGNAL LOSS indicator to illuminate, perform the following tests:

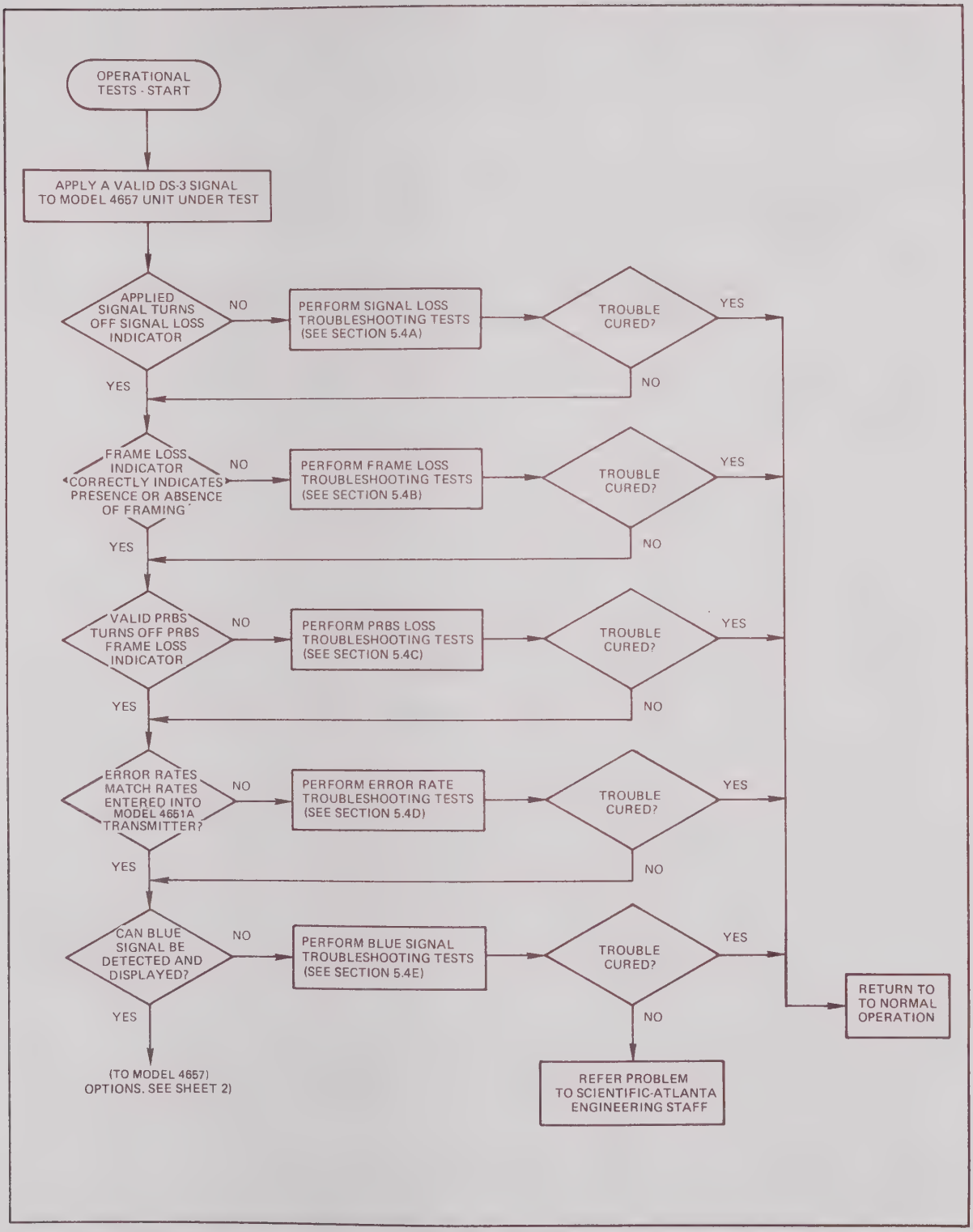


Figure 5.3. Troubleshooting Flow Chart Using Operational Tests (Sheet 1 of 2)

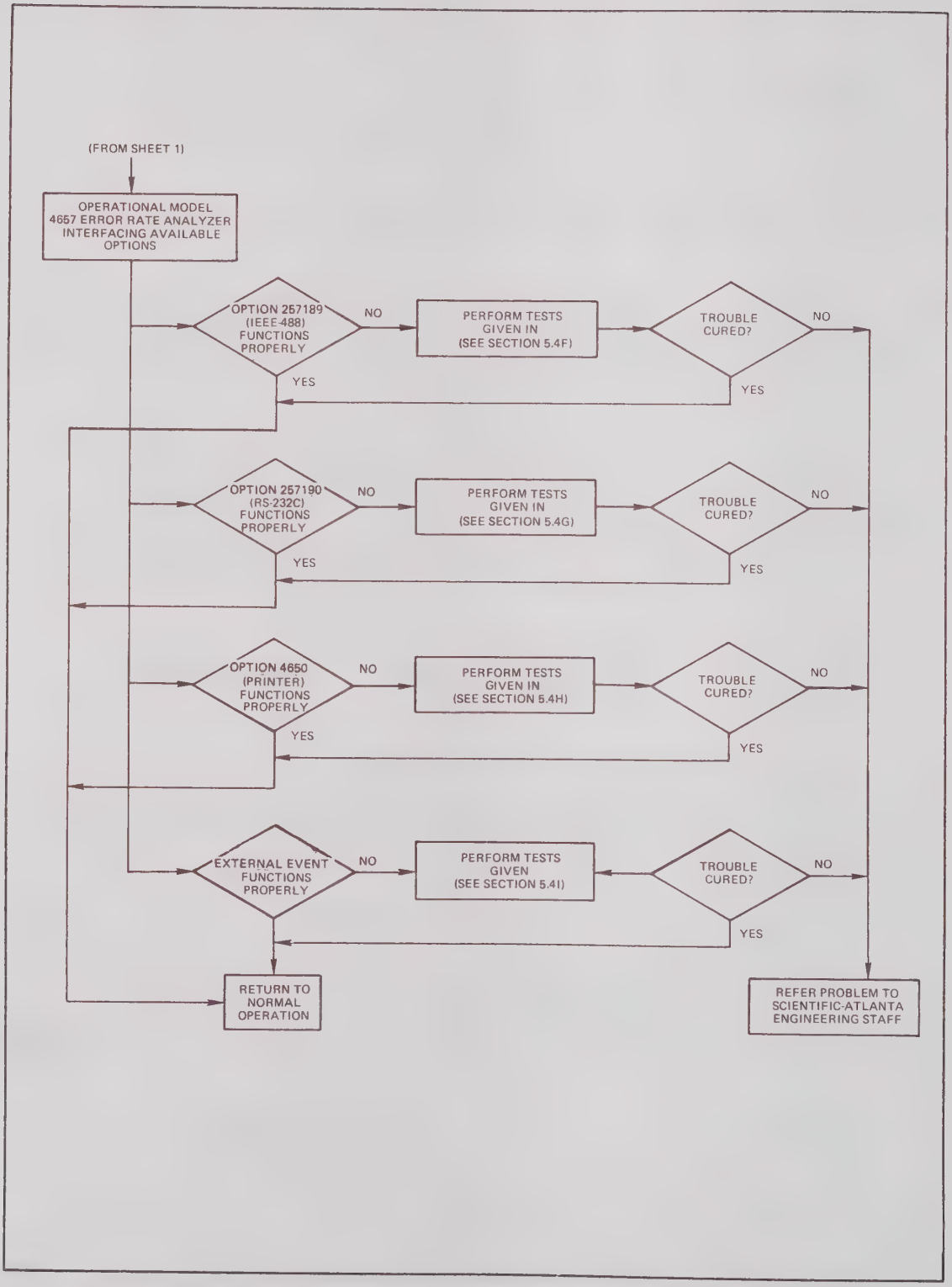


Figure 5.3. Troubleshooting Flow Chart Using Operational Tests (Sheet 2 of 2)

- Using a valid DS3 input signal, verify operation of the AGC circuits on the 44.7 MHz Clock Recovery PCB (A1). Observe the signal at test point TP2 (or at A1U3, pin 7) for a constant peak amplitude while alternately operating the LO/HI and DSX-3 switches on the front panel.

- Using either a DS3 or a NRZ input signal, measure the voltage change at A1U1, pin 7 on the 44.7 MHz Clock Recovery PCB (A1). The measurement should increase to >+10V dc when signal is applied.

- Observe the operation of transistor A1Q8 on the 44.7 MHz Clock Recovery PCB (A1). The transistor should switch ON when either a DS3 or NRZ signal is applied.

- Apply a valid DS3 signal (or an NRZ signal) and signal trace (using schematics in Chapter 7) circuit paths to the Error Counters 2 & 3 PCB (A7) and component A7U14, pin 2. If the malfunction has not been identified up to this point of testing, replace PCB A7 with one known to be functioning properly.

B. Frame Loss Failure

If normal operation of a Model 4657 Analyzer is indicated as in Section 5.3, but applying a Framed DS3 signal input does not extinguish the FRAME LOSS indicator, perform the following tests. Because of the complex circuitry required to recover and acknowledge the Framing signals, a malfunction of this nature is easier to troubleshoot when a second Model 4657 Analyzer (known to be functioning properly) is available. The following tests are started with two preliminary approaches to isolate a malfunction. Test 1 can be used if a good second Model 4657 Analyzer is available; or Test 2 should be used if a second analyzer is <u>not</u> available. Perform either Test 1 or Test 2, whichever meets your requirements. If the malfunction continues to exist, then proceed with Test 3. Be sure to observe ALL applicable Notes.

Notes:

1. If NRZ inputs are used in place of a valid DS3 signal, check the phasing of clock and data signals before testing. (Reference the Figure entitled "Clock and Data Timing Relationship for NRZ Input Signals" in the 4657 Analyzer Operator's Manual.)

2. If FRAMING cannot be acquired, observe if the Model 4657 Analyzer under test is counting Bipolar Violations for DS3 input. If Bipolar Violations are occuring, the indication is either a bad input or the improper extraction of data by circuits on the 44.7 MHz Clock Recovery PCB (A1).

TEST 1. Isolating a Frame Loss Malfunction Using a Second 4657 Analyzer

- Verify that the valid DS3 signal has proper framing.
- Substitute individual PCB's from the trouble-free Model 4657 Analyzer, one by one in the following sequence and observe after each substitution if the malfunction continues to occur. This substitution routine may provide some isolation of the malfunction.

  a. 44.7 MHz Clock Recovery PCB (A1)
  b. B3ZS Decoder and Blue Signal Detector PCB (A2)
  c. F-Frame Synchronizer PCB (A3)
  d. M-Frame Synchronizer PCB (A4)
  e. Error Counters 2 & 3 PCB (A7)

- If trouble continues, go to Test 3.

TEST 2. Isolating a Frame Loss Malfunction Without a Second 4657 Analyzer

- Verify that P5 and P6 on J3 are installed as follows:

  P5 should connect J3 pin 7 to pin 8, and P6 should be installed off center so as not to connect J3 pin 9 to pin 10.

- Verify operation of the 44.7 MHz Clock Recovery PCB (A1) by monitoring the four data outputs at connector A1J1, pins S, T, U, and V, while the Model 4651A BERTS Transmitter is providing an input signal of ALL ONES or the BLUE signal. This will provide a repeating pattern on each data output line.
- Check the accuracy of the DS3 clock phasing adjustment. (Refer to the Calibration Section.)
- Verify the operation of the B3ZS Decoder and Blue Signal Detector PCB (A2) by monitoring the data output signals at connector A2J1, pins 42 and 43, while the Model 4651A BERTS Transmitter is providing an input signal of ALL ONES, then ALL ZEROS, then the BLUE signal. Except for framing bits, the monitored data line should match the incoming data signal by remaining high, low, or displaying the BLUE signal squarewave.
- If trouble continues, go to Test 3.

TEST 3. Isolating a Frame Loss Malfunction: All Analyzers

- If a FRAME malfunction has not been isolated using either TEST 1 or TEST 2, then verify that the presence of the F-Frame signal is in sync (>+3.0V dc) on the F-Frame Synchronizer PCB (A3) at connector

A3J1, pin 1. Similarly, verify (1) the Gapped Clock signal at connector A3J1, pins 10 and 11; (2) the M-Clock signal at connector A3J1, pins 8 and 9; and (3) the F_1B signal (first F-bit of sequence) at connector A3J1, pins 22 and 21.

- Verify the M-Frame function by observing an in-sync line signal on the M-Frame Synchronizer PCB (A4) at connector A4J1, pin 39.
- Signal trace the F-Frame In-Sync and M-Frame In-Sync functions up to the Error Counters 2 & 3 PCB (A7).
- Thoroughly review the detailed circuit descriptions before troubleshooting applicable PCB's.

Note: Heat sensitive problems in ECL logic circuit components can usually be isolated to an individual component using a freeze spray such as "Super Freeze" manufactured by the Rawn Co.

C. PRBS Loss Failure

If normal operation of a Model 4657 Analyzer is indicated as in Section 5.3 but applying a PRBS DS3 signal input causes the PRBS FRAME panel indicator to illuminate, perform the following tests. It is presumed that SIGNAL LOSS and FRAME LOSS indicators are extinguished indicating normal operation of these functions.

- Verify that both Clock and Data input signals are being applied to the Pseudo Random Bit Sequence Generator PCB (A5).
- Check the signal functions associated with component A5U17 and verify the signal on the Sync Out line at connector A5J1, pin 33 of the Pseudo Random Bit Sequence Generator PCB (A5).
- Signal trace the signals from the Sync Out line (A5J1-33) to the Error Counters 2 & 3 PCB (A7).

D. Error Rate Mismatch

Normally, a Model 4657 Analyzer faithfully tracks the generated error rate programmed into a Model 4651A BERTS Transmitter output signal. When a malfunction of this nature occurs, the trouble should be isolated using the following tests.

Note: Be aware of the transmitter analyzer relationships. For example, during normal operation, a 10^{-3} BIT ERROR RATE (BER) selected on a Model 4651A BERTS Transmitter will be displayed as "1.60 x 10^{-4}" Parity Error on the Model 4657 Analyzer. Also, when synchronous Error Seconds are selected, the Error Seconds display may not increment smoothly, due to the lack of synchronization between the Error Seconds and the one-second display update rate. Other "Errors" are directly displayed as programmed.

- Configure a Model 4651A BERTS Transmitter to output ALL ONES DATA with 10^{-3} BIT ERROR RATE. At the analyzer under test, verify the presence of 11ns pulses with a 22µs period on the Error Counter 1 PCB (A6) at connector A6J1, pins 29 and 30. If pulses cannot be verified, troubleshoot and repair the Pseudo Random Generator Bit Sequence Generator PCB (A5).

- On the Error Counter 1 PCB (A6), signal trace errors through counters A6U2, A6U3, and A6U4. Verify operation of the Million Bit Divider by observing that the output pulse at A6U11, pin 9 has a 22ms period.

- Signal trace Parity Errors detected in the M-Frame Synchronizer PCB (A4) circuitry to the Error Counters 2 & 3 PCB (A7) counter components A7U4 and A7U5. Verify the presence of the Million Bit Strobe pulse at A7U12, pin 11.

- Signal trace Bipolar Violation from the B3ZS Decoder and Blue Signal Detector PCB (A2) circuitry to the Error Counters 2 & 3 (A7) counter components A7U1, A7U2, and A7U3. Verify the presence of the Million Bit Strobe pulse at A7U19, pin 11 and A7U11, pin 11.

E. Blue Signal Detection Malfunction

If a Model 4657 Analyzer fails to provide the BLUE signal display when the associated Model 4651A BERTS Transmitter is properly conditioned (i.e., both OUTPUT switches, ALL ONES and PSEUDO RANDOM DATA, operated), the malfunction should be rapidly isolated using the schematics in Chapter 7 and the following tests:

- Make sure the unit is in RUN mode displaying BIT data.

- Observe and verify the Blue Signal Detection circuit operation on the B3ZS Decoder and Blue Signal Detector PCB (A2).

- Observe and verify the BLUE signal output generated on the Error Counters 2 & 3 PCB (A7).

F. Option IEEE-488 257189 Malfunction

If difficulties are encountered, perform the following tests on the unit:

- Refer to the Operator's Manual to verify or reset Address coding.
- Thoroughly check the flat cable interfacing between the rear panel connector and the IEEE-488 Interface PCB (A8).

G. Option RS-232 257190 Malfunction

If difficulties are encountered, perform the following tests on the unit:

- Refer to the Operator's Manual to verify or reset the Baud Rate and other jumpers.
- Thoroughly check the flat cable interfacing between the rear panel connector and the RS-232C Interface PCB (A8).

H. Option Printer Model 4650 Malfunction

If difficulties are encountered with Model 4650, the Local Printer, perform the following tests on the unit. Note that the printer mechanism and Control/Drive Card are purchased items and available documentation has been included in Chapter 4.

- Refer to the Operator's Manual and cause the Local Printer to perform a Self-Test.
- Check for a marginal or bad component on the Local Printer I/O Interface PCB (A2). See Chapter 7 for the schematic diagram.

I. External Event Monitor Malfunction

If difficulties are encountered, perform the following tests on the unit:

- Verify that input voltages appear at the J1 connector on the Error Counter 1/External Event Monitor PCB (A6).

- Verify that each integrated circuit has power and ground on the appropriate pins.
- Verify that pulses are present at U18 pins 13 and 14 and at U21 pin 3.
- Verify that Q2 and Q3 turn on when they are selected.
- If calibration of the front panel display is necessary, first make sure that a calibrated DVM is available. Then connect BOTH 4657 DC voltage inputs to any DC Voltage source. Measuring this voltage at the source with the DVM, adjust R32 such that the two input voltages on the front panel agree with the DVM (or that any error is split between the two inputs).
- Verify that U22, pins 17 and 18, toggle to reflect openings and closures of the two DRY CONTACT inputs.
- A "+99.98" or a "-99.98" indicates a failure of the A-to-D circuitry.

5.5 CALIBRATION

The following procedures describe adjustments which can be accomplished under normal conditions in a general electronic repair center. Adjustments to the power supply are provided in the first procedure. Otherwise, there are six calibration adjustments for the Model 4657 Analyzer.

A. Test Equipment

The test equipment or its equivalent listed in Table 5.1 is required to perform the tests in this procedure. All test equipment must be calibrated and operating within is specified accuracy.

B. -5.2V/-12.0V DC Power Supply Calibration

The -5.2V/-12.0V Power Supply PCB will be calibrated in the unit operating under loaded conditions. The ac source should be removed and a -20V dc source should be applied to the "DC POWER" connector. With the external dc power source off, extract the power supply PCB and lay it on top of the chassis with cables attached. Use insulating material such as cardboard for safety. Switch the dc power source on.

Table 5.1
Test Equipment

Description	Model	QTY	Manufacturer
DVM	3465A	1	Hewlett-Packard
Oscilloscope	475	1	Tektronix
Frequency/Period Counter	5315A	1	Hewlett-Packard
DC Supply, 0-60V, 9A	DCR 60-9B	1	Sorenson
IF Sweeper	1700	1	General Radio
RF Network Analyzer	1710	1	General Radio
75 Ohm Termination	011055	2	Tektronix
Probe, FET	P6201	2	Tektronix
Probe, 1MΩ	P6106	2	Tektronix

Connect the DVM to monitor the -12.0V dc output between J1-3 (common) and J1-9. Adjust variable resistor R7 counterclockwise two turns from the point it last affects the measured -12.0V dc output.

Connect the DVM to monitor the -5.2V dc output between J1-3 (common) and J1-1. Adjust variable resistor R30 counterclockwise two turns from the point it last affects the measured -5.2V dc output.

Adjust variable resistor R23 to set the -5.2V dc output to -5.25(±0.1)V dc.

Adjust variable resistor R30 slowly clockwise to the point the DVM indication starts to decrease. Then adjust R30 counterclockwise two turns from this point.

Connect the DVM to monitor the -12.0V outputs between J1-3 and J1-9. The DVM should indicate -12.0(±0.3)V dc. Adjust variable resistor R7 slowly clockwise until the -12.0V dc outputs start to decrease, then adjust R7 counterclockwise two turns from this point. This completes calibration of the -5.2V/-12.0V Power Supply PCB.

C. +5.0V/+12.0V DC Power Supply Calibration

The +5.0V/+12.0V Power Supply PCB is accessible by removing chassis top cover and retainer. With the external dc power source off, extract the power

supply PCB. With cables connected, place it on an insulating material (such as cardboard) on top of the unit. Switch the power source on to provide a +20V dc source to the "DC POWER" connector.

Adjust variable resistors R1 and R17 three turns counterclockwise. Connect the DVM to monitor the +12V output between J1-5 (common) and J1-1. Adjust variable resistor R4 until the DVM indicates 12.0(±0.1)V dc.

Adjust variable resistor R1 slowly clockwise until the DVM indication starts to decrease, then adjust R1 counterclockwise two turns.

Connect the DVM to monitor the +5V output between J1-5 (common) and J1-3. Adjust variable resistor R20 until the DVM indicates 5.1(±0.1)V dc.

Adjust variable resistor R17 slowly clockwise until the DVM indication starts to decrease. Then adjust R17 counterclockwise two turns. This completes calibration of the +5.0/+12V Power Supply PCB.

D. Model 4657 Analyzer Calibration

1. 44.7 MHz Clock Recovery Adjust

AGC Calibrate. With power off, install the 44.7 MHz CLOCK RECOVERY PCB (A1) on an extender card into slot A1 (see Figure 5.4). Switch power ON and apply a valid DS3 signal from a Model 4651A BERTS Transmitter (conditioned for LOW (OUTPUT LEVEL), ALL ONES (OUTPUT), and CLOCK-INT) to A1J1. Using the FET oscilloscope probe, monitor A1TP1 (or A1U3, pin 7). Ground return for the probe should be as near A1TP1 as possible. Adjust variable resistor A1R21 for a signal which switches 400 mV above ECL threshold. (See Figure 5.5.)

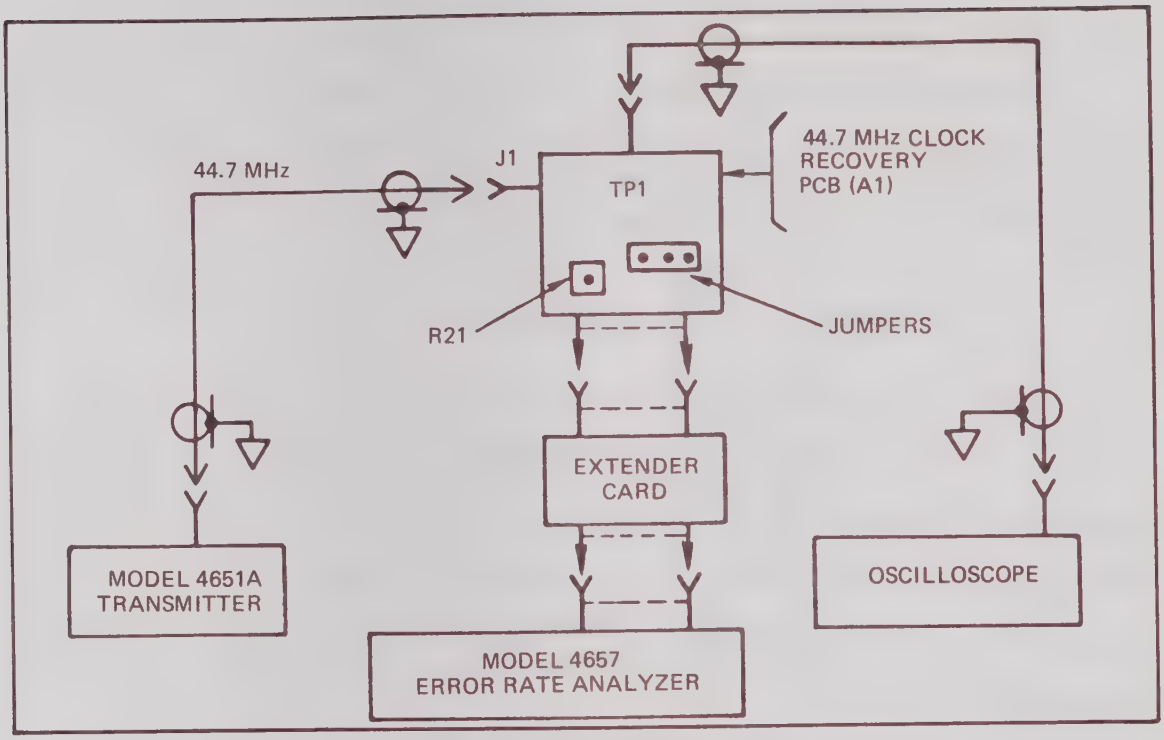


Figure 5.4. Clock Recovery AGC Test Configuration

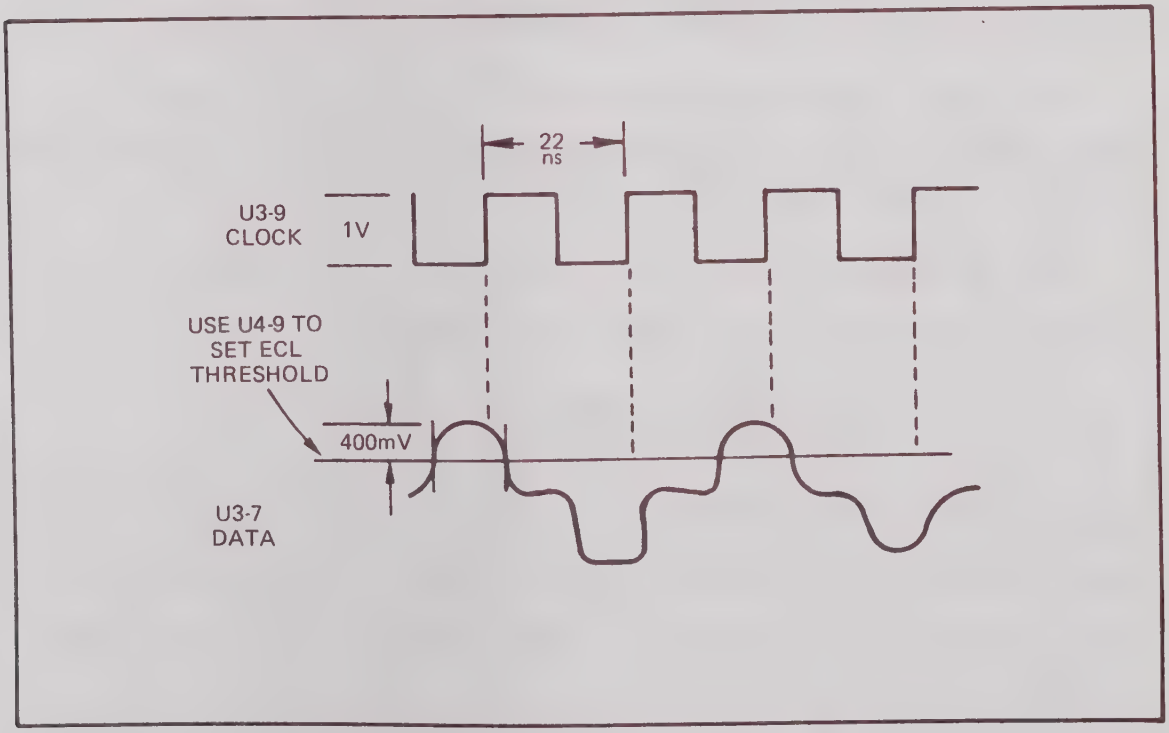


Figure 5.5. Clock and Data Phasing

2. Clock Recovery Filter Adjust

Remove the transmitter input at A1J1. Set jumper P2 on A1J3 for the sweep test position, A1J3-2 to A1J3-3. Sweep the filter by connecting the sweeper to A1J2 and A1J4 (see Figure 5.6). Adjust A1C29 and A1C31 to give the filter characteristic shown in Figure 5.7.

3. Clock and Data Phasing Adjust

Remove the sweeper and set P2 on A1J3 for normal operation, A1J3-1 to A1J3-2. Connect a Model 4651A BERTS Transmitter "DS3 OUTPUT" to A1J1 input. Set the transmitter front panel switches for "ALL ONES DATA" and "HIGH-OUTPUT LEVEL" with "INTernal CLOCK". Use the oscilloscope with low capacitance (FET) probes to monitor A1U3 pins 7 and 9 in a dual trace mode. Adjust variable resistor R51 to give timing relation shown in Figure 5.5. The rising edge of clock should occur at a point half way through period that data is above threshold.

4. A2 B3ZS Decoder Adjustments

With power off, install the B3ZS Decoder PCB (A2) to be tested on an extender card into slot A2. Check that jumpers are set for D and BIP before starting the test. Switch chassis power on.

Use the DVM and adjust variable resistor A2R44 so that A2U13, pin 6, measures -0.25(±0.010)V dc with respect to A2U13, pin 9.

5. Real-Time Clock Calibrate

Setting the Clock Frequency. With power off, install the Real-Time Clock PCB (A9) to be tested on a card extender into slot A9. Apply ac power and monitor A10U16-3 using the Frequency/Period Counter. Set the Counter to measure a period with 1μs resolution. Adjust A10C1 to set the timer period to 500,000(±3)μs.

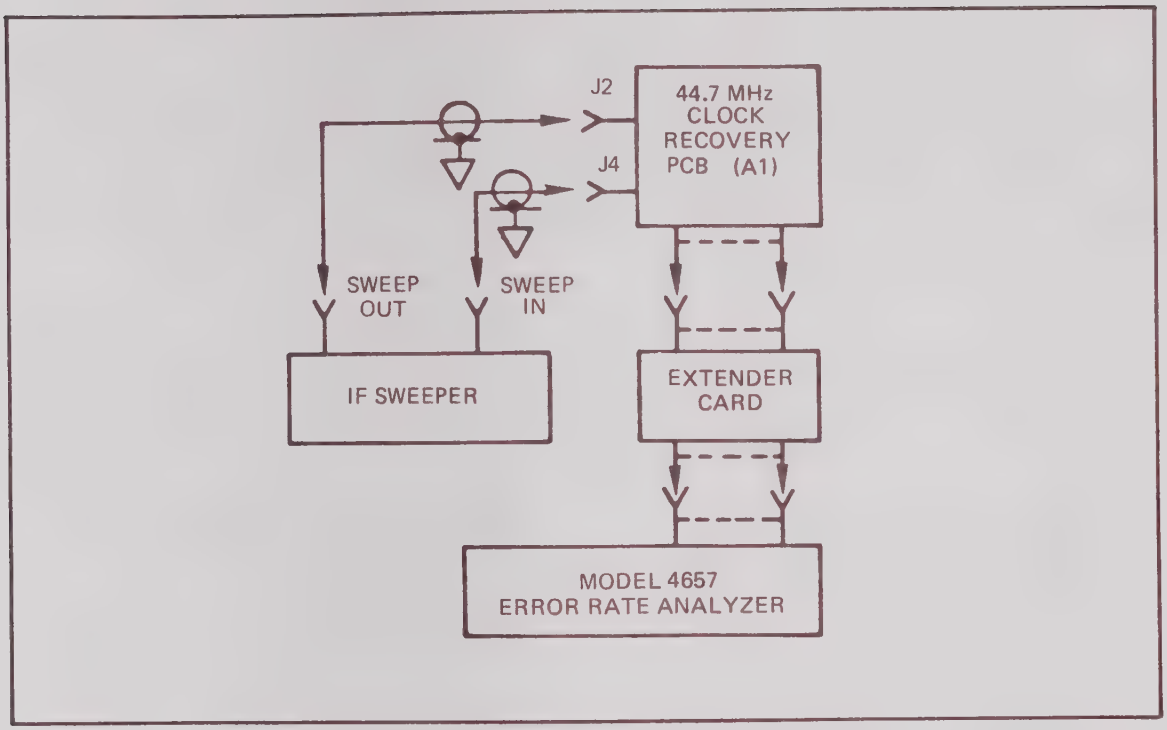


Figure 5.6. 44.7 MHz Filter Connection

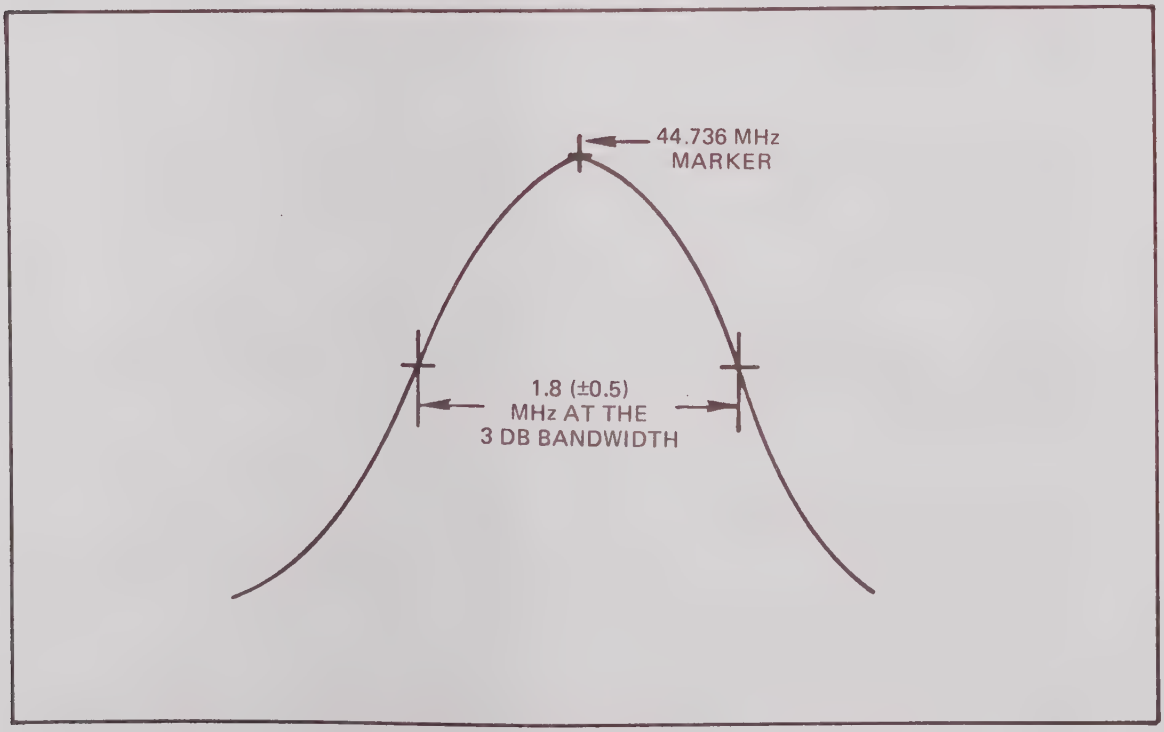


Figure 5.7. 44.7 MHz Filter Response

5.6 REGIONAL SERVICE CENTERS

Regional Service Centers capable of performing periodic maintenance and providing assistance associated with the Model 4657 Analyzer and other Scientific-Atlanta equipment are listed below. Service Assistance for areas not listed can be provided through the Scientific-Atlanta Field Service Center, 4025 Pleasantdale Road, Atlanta, Georgia 30340; TEL: 404-441-4200; TWX: 810-766-4912; TELEX: 0542898.

NORTH AMERICAN REGIONAL SERVICE CENTERS

Northeastern Regional Office
149 Middlesex Turnpike
Burlington, Massachusetts 01803
Tel: 617-272-1256

Washington D.C. Regional Office
Washington Business Park
5100-J Philadelphia Way
Tanham, Maryland 20706
Tel: 301-577-4830

Mid Atlantic Regional Office
2100 Route 208
Fair Lawn, New Jersey 07410
Tel: 201-791-8777

Southeastern Regional Office
4025 Pleasantdale Road
Atlanta, Georgia 30340
Tel: 404-449-2021

Florida Regional Office
P.O. Box 2143
841 West Emmett St.
Kissimmee, Florida 32741
Tel: 305-846-0055

Midwest Regional Office
Fidelity Bldg., Suite 306
11550 N. Meridian
Carmel, Indiana 46032
Tel: 317-846-7142

Chicago Service Center
621 East Butterfield Rd., Suite 219
Lombard, Illinois 60148
Tel: 312-963-6375

Southwestern Regional Office
1237 Executive Drive, East
Richardson, Texas 75081
Tel: 214-238-1116

Denver Service Center
103 Inverness Dr. East
Inglewood, Colorado 80112
Tel: 303-790-0585

So. California Regional Office
P.O. Box 2668
10039 Pioneer Boulevard
Santa Fe Springs, California 90670
Tel: 213-949-9411

No. California Regional Office
3375 Scott Boulevard, Suite 304
Santa Clara, California 95051
Tel: 408-496-1040

INTERNATIONAL SERVICE CENTERS

CANADA
Scientific-Atlanta, Ltd.
1640 Bonhill Road
Unit 6
Mississauga, Ontario L5T1C8
Tel: 416-677-6555
Telex: 06983600

GERMANY
Scientific-Atlanta GmbH
Albert Schweitzerstrasse 66/3
D-8000 Munich 83, Germany
Tel: 49.8967.1091
Telex: 5212264

ENGLAND
Scientific-Atlanta, Ltd.
Horton Manor
Stanwell Road
Horton
Slough SL3 9PA, England
Tel: 44.2812-3211
Telex: 849406

ITALY
Scientific-Atlanta, S.p.A.
Via Benedetto Croce 19
00142 Rome, Italy
Tel: 39.6.5420244
Telex: 721441

FRANCE
Scientific-Atlanta S.A.
4 Avenue Gabriel Peri
78360 Montesson
France
Tel: 33.3.9769191
Telex: #46385

CHAPTER 6
PARTS LISTS

6.1 GENERAL

The parts lists for a Model 4657 DS3 Error Rate Analyzer are included in this chapter. Special modifications, if any, are enclosed in the envelope in the rear of this manual.

6.2 EXPLANATION OF COLUMN HEADINGS

REF. DESIG. PREFIX. This identifies the assigned reference designation applicable to a system or equipment sub-unit having a separate prefix and arrangement of individual components.

REF. DESIG. This identifies the components of the sub-unit in alphanumerical order.

PART NO. A five or six digit number assigned by Scientific-Atlanta to the specific part for identification and correct replacement ordering information.

DESCRIPTION. A brief electrical and/or mechanical description of the component.

FSCM CODE. The proper Federal Supply Code for Manufacturers is entered in this column. The code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and are in effect as of the publication date of this manual.

VENDOR PART NUMBER. The number assigned to a part by an outside supplying manufacturer is listed in this column.

6.3 ORDERING PARTS

When ordering parts from Scientific-Atlanta, always include the Scientific-Atlanta part number, the part description, the unit name, the unit serial number, the subassembly name, the part manufacturer (FSCM), and the manufacturer's part number.

6.4 PARTS SUBSTITUTION

Common components may differ from those identified in the parts list. This difference is due to the substitution of a more current part during assembly. When this occurs, the replacement may be either a part identical to the type removed or a part meeting the description given in the parts list.

INDEX

Desig.	Ref Part No.	Description	Page
A1	252858	44.7 MHz Clock Recovery Assembly	6-4
A2	220861	B3ZS Decoder and Blue Signal Det Assembly	6-7
A3	252786	F-Frame Sync Assembly	6-9
A4	220885	M-Frame Sync Assembly	6-11
A5	310991	Pseudo Random Bit Sequence Gen Assembly	6-13
A6	252866	Error Counter 1/External Event Monitor Assembly	6-15
A7	252917	Error Counters 2 & 3 Assembly	6-17
A9	304256	Real-Time Clock Assembly	6-18
A10	304253	8080 CPU Assembly	6-20
A11	252893	Motherboard Assembly	6-22
A12	220905	-5.2V/-12V Power Supply Assembly	6-23
A13	220917	+5V/+12V Power Supply Assembly	6-26
A14	252853	Front Panel Assembly	6-28
A14A1	255770	Clock Display Assembly	6-29
A14A2	252888	Error Display Assembly	6-29
A14A3	252899	Front Panel I/O Assembly	6-30
A14A4	252863	Front Panel Error Rate Analyzer Assembly	6-31
A15	256296	Rear Panel Assembly	6-33
A15A1	252781	Rectifier and Filter Assembly	6-33
	257189	IEEE-488 Interface Option Assembly	6-34
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	221020	Model 4650 Optional Printer Assembly	6-35
	221002	Model 4650 Optional - I/O Interface Assembly	6-36
	221014	Model 4650 - Control/Drive Assembly	
	220999	Model 4650 - Flex Cable Assembly	6-36
	257137	DCV/Alarm Rear Panel Interface Cable Assembly	6-37
	252859	DCV/Alarm Monitor Cable Assembly	6-37
	220947	Power Wiring Harness	
	220983	Local Printer Interface Cable	
	71226	Fuse 2.5 Amp Slo Blo	
	89762	Cord Set, 3-wire #18, 125V, 9 ft.	

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REF DESIG PREFIX: 4657-A1

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0081834	CAPACITR 77 PF 500V SILVER MICA 2%	53021	D155C770G03
C 2	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 3	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 4	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 5	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 6	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	05397	T362D107K020AS
C 7	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 8	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 9	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	05397	T362D107K020AS
C 10	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	05397	T362D107K020AS
C 11	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 12	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 13	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 14	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	05397	T362D107K020AS
C 16	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 17	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 18	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 19	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 20	0070504	CAPACITR 50 PF 1 KV CER DISC S3N 10%	71590	DD-500
C 21	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 22	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 23	0081934	CAPACITR 18 PF 100V CER DISC COG 5%	72982	835-C0G0-180J
C 24	0082006	CAPACITR 3,9 PF 100V CER DISC COJ +-.25P	72982	835-024-COJO-399C
C 25	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 26	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 27	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 28	0084388	CAPACITR 91 PF 500V SILVER MICA 1%	14655	CD15FD910F03
C 29	0079171	CAPACITR 9-35 PF MIN CER DISC PC MT	72982	538-011 D 9-35
C 30	0082006	CAPACITR 3,9 PF 100V CER DISC COJ +-.25P	72982	835-024-COJO-399C
C 31	0079171	CAPACITR 9-35 PF MIN CER DISC PC MT	72982	538-011 D 9-35
C 32	0084388	CAPACITR 91 PF 500V SILVER MICA 1%	14655	CD15FD910F03
C 34	0070492	CAPACITR 33 PF 500V SILVER MICA 5%	14655	CD15ED330J03
C 35	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 36	0070540	CAPACITR 470 PF 1KV CER DISC Z5F 10%	71590	DD-471
C 37	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 38	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 39	0070540	CAPACITR 470 PF 1KV CER DISC Z5F 10%	71590	DD-471
C 40	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 41	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 42	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 43	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 44	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 45	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 46	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 47	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 48	0082006	CAPACITR 3,9 PF 100V CER DISC COJ +-.25P	72982	835-024-COJO-399C
C 49	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
CR 1	0255147	DIODE PIN		
CR 2	0255147	DIODE PIN		
CR 3	0255147	DIODE PIN		
CR 4	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR 5	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR 6	0083618	DIODE 5082-2800 DET UHF SCHOTTKY	28480	5082-2800
CR 7	0083618	DIODE 5082-2800 DET UHF SCHOTTKY	28480	5082-2800
CR 8	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 9	0083618	DIODE 5082-2800 DET UHF SCHOTTKY	28480	5082-2800
CR 10	0083618	DIODE 5082-2800 DET UHF SCHOTTKY	28480	5082-2800
CR 11	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
E 1	0081718	CORE BEAD FERRITE 7D .138X.037X.150L GRN	78488	57-1413
E 2	0081718	CORE BEAD FERRITE 7D .138X.037X.150L GRN	78488	57-1413
E 3	0081718	CORE BEAD FERRITE 7D .138X.037X.150L GRN	78488	57-1413
E 4	0081718	CORE BEAD FERRITE 7D .138X.037X.150L GRN	78488	57-1413
E 5	0081718	CORE BEAD FERRITE 7D .138X.037X.150L GRN	78488	57-1413

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REF DESIG PREFIX: 4657-A1

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
J 1	0087018	CONN COAX SMB MALE PC MT RT ANGLE 75 OHM		51-153-0000
J 2	0084940	CONN COAX SMB MALE PC MT 75 OHM	98291	51-151-0000
J 3	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC		87220-3
J 4	0087018	CONN COAX SMB MALE PC MT RT ANGLE 75 OHM		51-153-0000
K 1	0085285	RELAY 12VDC TO-5 PKG		732-12
L 1	0079330	INDUCTOR ,22 UH SUBMIN UNSHLD 10%	91637	IR-2
L 2	0079330	INDUCTOR ,22 UH SUBMIN UNSHLD 10%	91637	IR-2
L 3	0079926	INDUCTOR 10 UH SUBMIN UNSHLD 10%	91637	IR-2
L 4	0079926	INDUCTOR 10 UH SUBMIN UNSHLD 10%	91637	IR-2
L 6	0079166	INDUCTOR ,15 UH SUBMIN UNSHLD 10%	91637	IR-2
L 7	0080599	INDUCTOR 4,7 UH SUBMIN UNSHLD 10%	91637	IR-2
L 8	0081082	INDUCTOR ,12 UH SUBMIN UNSHLD 10%	91637	IR-2
L 9	0081082	INDUCTOR ,12 UH SUBMIN UNSHLD 10%	91637	IR-2
P 2	0086884	JUMPER FEMALE INSULATED ,10 SPACING		65474-004
Q 1	0075091	TRANSSTR 2N2857 NPN SIL	04713	2N2857
Q 2	0075091	TRANSSTR 2N2857 NPN SIL	04713	2N2857
Q 3	0080976	TRANSSTR 2N3251 PNP SIL SELECTED	04713	2N3251SA
Q 4	0075091	TRANSSTR 2N2857 NPN SIL	04713	2N2857
Q 5	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 6	0077147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
Q 7	0085042	TRANSSTR MRF 517 NPN SIL	04713	MRF 517
Q 8	0077147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
Q 9	0075091	TRANSSTR 2N2857 NPN SIL	04713	2N2857
Q 10	0085042	TRANSSTR MRF 517 NPN SIL	04713	MRF 517
Q 11	0077147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
Q 12	0085042	TRANSSTR MRF 517 NPN SIL	04713	MRF 517
R 1	0083855	RESISTOR 105 OHM RN55C 1% MTL FLM		RN55C1050F
R 2	0083089	RESISTOR 75,0 OHM RN55C 1% MTL FLM		RN55C75R0F
R 3	0083089	RESISTOR 75,0 OHM RN55C 1% MTL FLM		RN55C75R0F
R 4	0078919	RESISTOR 44,2 OHM RN55D 1% MTL FLM		RN55C44R2F
R 5	0077524	RESISTOR 75 OHM 1/4W 5% COMP	01121	RCR07G750JS
R 6	0071951	RESISTOR 1,0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 7	0071960	RESISTOR 1,2K OHM 1/4W 10% COMP	01121	RCR07G122KS
R 8	0071951	RESISTOR 1,0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 9	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 10	0071951	RESISTOR 1,0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 11	0071889	RESISTOR 100 OHM 1/2W 10% COMP	01121	RCR20G101KS
R 12	0072002	RESISTOR 4,7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 13	0072039	RESISTOR 15K OHM 1/4W 10% COMP	01121	RCR07G153KS
R 14	0072002	RESISTOR 4,7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 15	0072002	RESISTOR 4,7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 16	0072189	RESISTOR 1,0 MEG 1/4W 10% COMP	01121	RCR07G105KS
R 17	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 18	0071862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R 19	0072059	RESISTOR 27K OHM 1/4W 10% COMP	01121	RCR07G273KS
R 20	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 21	0087840	POT 10K OHM 1/2W CER 3/8 SQ VERT ADJ 25T		3299W-1-103
R 22	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 23	0072147	RESISTOR 270K OHM 1/4W 10% COMP	01121	RCR07G274KS
R 24	0071862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R 25	0079864	RESISTOR 24,9K OHM RN55C 1% MTL FLM		RN55C2492F
R 26	0077524	RESISTOR 75 OHM 1/4W 5% COMP	01121	RCR07G750JS
R 27	0072113	RESISTOR 100K OHM 1/4W 10% COMP	01121	RCR07G104KS
R 28	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 29	0071926	RESISTOR 470 OHM 1/4W 10% COMP	01121	RCR07G471KS
R 30	0071876	RESISTOR 68 OHM 1/4W 10% COMP	01121	RCR07G680KS
R 31	0071876	RESISTOR 68 OHM 1/4W 10% COMP	01121	RCR07G680KS
R 32	0071862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS

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REF DESIG PREFIX: 4657-A1

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
R 33	0071926	RESISTOR 470 OHM 1/4W 10% COMP	01121	RCR07G471KS
R 34	0071926	RESISTOR 470 OHM 1/4W 10% COMP	01121	RCR07G471KS
R 35	0071926	RESISTOR 470 OHM 1/4W 10% COMP	01121	RCR07G471KS
R 36	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 37	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 38	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 39	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 40	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 41	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 42	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 43	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 44	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 45	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 46	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 47	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 48	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 49	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 50	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 51	0087837	POT 1K OHM 1/2W CER 3/8 SQ VERT ADJ 25T		3299W-1-102
R 52	0071895	RESISTOR 120 OHM 1/2W 10% COMP	01121	RCR20G121KS
R 53	0071880	RESISTOR 82 OHM 1/2W 10% COMP	01121	RCR20G820KS
R 54	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 55	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 56	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 57	0071960	RESISTOR 1.2K OHM 1/4W 10% COMP	01121	RCR07G122KS
R 58	0072088	RESISTOR 56K OHM 1/4W 10% COMP	01121	RCR07G563KS
R 59	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 60	0083891	RESISTOR 1.50K OHM RN55C 1% MTL FLM		RN55C1501F
R 61	0083853	RESISTOR 82.5 OHM RN55C 1% MTL FLM		RN55C82R5F
R 63	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 64	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 65	0071920	RESISTOR 390 OHM 1/4W 10% COMP	01121	RCR07G391KS
R 68	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 69	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 70	0071926	RESISTOR 470 OHM 1/4W 10% COMP	01121	RCR07G471KS
R 71	0071862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R 72	0071926	RESISTOR 470 OHM 1/4W 10% COMP	01121	RCR07G471KS
R 73	0071920	RESISTOR 390 OHM 1/4W 10% COMP	01121	RCR07G391KS
T 1	0084083	XFMR MATCHING .2-350 MHZ 50 IN 200CT OUT		T4-1
T 2	0084083	XFMR MATCHING .2-350 MHZ 50 IN 200CT OUT		T4-1
TP 1	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
TP 2	0081632	SOCKET PIN .040 DIA CLOSED BOTTOM	71279	450-3704-01-06-00
TP 3	0081632	SOCKET PIN .040 DIA CLOSED BOTTOM	71279	450-3704-01-06-00
TP 4	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
U 1	0086632	IC OP AMP 8L-DIP 70C COMP DUAL 741C		MC1458CU
U 2	0089652	IC ECL GATE OR 2-IN QUAD 3 OR-1 OR/NOR		F10103DC
U 3	0088406	IC ECL FLIP-FLOP TYPE-D 160MHZ M/S DUAL		F10131DC
U 4	0089658	IC ECL LINE RECEIVER TRIPLE		F10116DC
U 5	0089658	IC ECL LINE RECEIVER TRIPLE		F10116DC

B3ZS DECODER AND BLUE SIGNAL DET. ASSEMBLY - 220861

REF DESIG PREFIX: 4657-A2

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 2	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 3	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 4	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 5	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 6	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 7	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 8	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 9	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 10	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 11	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 12	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 13	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 14	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 15	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 16	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 17	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 18	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 19	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 20	0070544	CAPACITR .001 MF 1KV CER DISC Z5F 10%	71590	DD102
CR 1	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 2	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
J 1	0087018	CONN COAX SMB MALE PC MT RT ANGLE 75 OHM		51-153-0000
J 2	0087018	CONN COAX SMB MALE PC MT RT ANGLE 75 OHM		51-153-0000
J 3	0087018	CONN COAX SMB MALE PC MT RT ANGLE 75 OHM		51-153-0000
J 4	0087018	CONN COAX SMB MALE PC MT RT ANGLE 75 OHM		51-153-0000
J 5	0087378	CONN HEADER DBL ROW STRAIGHT 6-PIN PC		1-87215-2
J 6	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC		87220-3
P 2	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
P 3	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
R 1		NOT ASSIGNED		
R 2	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 3		NOT ASSIGNED		
R 4	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 5	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 6	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 7	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 8	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 9	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 10	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 11	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 12	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 13	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 14	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 15	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 16	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 17	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 18	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 19	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 20	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 21	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 22	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 23	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 24	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 25	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 26	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 27	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 28	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 29		NOT ASSIGNED		

B3ZS DECODER AND BLUE SIGNAL DET. ASSEMBLY - 220861

REF DESIG PREFIX: 4657-A2

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
R 30		NOT ASSIGNED		
R 31	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 32		NOT ASSIGNED		
R 33	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 34	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 35	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 36	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 37	0083855	RESISTOR 105 OHM RN55C 1% MTL FLM		RN55C1050F
R 38	0083091	RESISTOR 140 OHM RN55C 1% MTL FLM		RN55C1400F
R 39	0083876	RESISTOR 499 OHM RN55C 1% MTL FLM		RN55C4990F
R 40	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 41	0083867	RESISTOR 249 OHM RN55C 1% MTL FLM		RN55C2490F
R 42	0083867	RESISTOR 249 OHM RN55C 1% MTL FLM		RN55C2490F
R 43	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 44	0087289	POT 200 OHM 3/4W CER RECT 3/4 LONG 20T		3009P-1-201
R 45	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 46	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 47	0072113	RESISTOR 100K OHM 1/4W 10% COMP	01121	RCR07G104KS
R 48	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 49	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 50	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 51	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 52	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
U 1	0088406	IC ECL FLIP-FLOP TYPE-D 160MHZ M/S DUAL		F10131DC
U 2	0088406	IC ECL FLIP-FLOP TYPE-D 160MHZ M/S DUAL		F10131DC
U 3	0089659	IC ECL FLIP-FLOP TYPE-JK DUAL MASTR/SLAV		F10135DC
U 4	0089654	IC ECL GATE NOR/OR 2/3/2-IN TRIPLE		F10105DC
U 5	0089654	IC ECL GATE NOR/OR 2/3/2-IN TRIPLE		F10105DC
U 6	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR		F10102DC
U 7	0086633	IC ECL LINE RECEIVER QUAD		MC10115L
U 8	0088405	IC ECL TRANSLATOR ECL/TTL QUAD		F10125DC
U 9	0087694	IC TTL BUFFER NAND 4-IN DUAL		SN74S140J
U 10	0087694	IC TTL BUFFER NAND 4-IN DUAL		SN74S140J
U 11	0088406	IC ECL FLIP-FLOP TYPE-D 160MHZ M/S DUAL		F10131DC
U 12	0089656	IC ECL GATE EX OR/NOR 2-IN TRIPLE		F10107DC
U 13	0086633	IC ECL LINE RECEIVER QUAD		MC10115L
U 14	0170206	IC ECL TRANSLATOR TTL TO ECL QUAD		F10124DC
U 15	0252947	IC MULTI MONO REGRIG DUAL		SN54LS123J

F-FRAME SYNCHRONIZER ASSEMBLY - 252786

REF DESIG PREFIX: 4657-A3

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 2	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 3		NOT ASSIGNED		
C 4	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 5	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 6	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 7	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 8	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 9	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 10	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 11	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 12	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 13	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 14	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 15	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 16	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 17	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 18	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 19	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 20	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 21	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 22	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 23	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-102K
R 1	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 2	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 3	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 4	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 5	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 6	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 7	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 8	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 9	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 10	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 11	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 12	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 13	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 14	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 15	0071966	RESISTOR 1.5K OHM 1/4W 10% COMP	01121	RCR07G152KS
R 16	0071913	RESISTOR 270 OHM 1/4W 10% COMP	01121	RCR07G271KS
R 17	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 18	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 19	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 20	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 21	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 22	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 23	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 24	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 25	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 26	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 27	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 28	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 29	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 30	0071966	RESISTOR 1.5K OHM 1/4W 10% COMP	01121	RCR07G152KS
R 31	0071913	RESISTOR 270 OHM 1/4W 10% COMP	01121	RCR07G271KS
R 32	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 33	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 34	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 35	0087000	FINAL SELECTION NOT YET MADE		
R 36	0087000	FINAL SELECTION NOT YET MADE		
R 37	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 38	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 39	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 40	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 41	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 42	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 43	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 44	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 45	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS

F-FRAME SYNCHRONIZER ASSEMBLY - 252786

REF DESIG PREFIX: 4657-A3

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
R 46	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 47	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 48	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 49	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 50	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 51	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 52	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 53	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 54	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 55	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 56	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 57	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 58	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 59	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 60	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 61	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 62	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 63	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 64	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 65	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 66	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 67	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 68	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 69	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 70	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 71	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 72	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 73	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 74	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 75	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
TP 1	0073318	WIRE 22 BUS	70903	8021
TP 2	0073318	WIRE 22 BUS	70903	8021
TP 3	0073318	WIRE 22 BUS	70903	8021
TP 4	0073318	WIRE 22 BUS	70903	8021
TP 5	0073318	WIRE 22 BUS	70903	8021
TP 6	0073318	WIRE 22 BUS	70903	8021
TP 7	0073318	WIRE 22 BUS	70903	8021
TP 8	0073318	WIRE 22 BUS	70903	8021
TP 9	0073318	WIRE 22 BUS	70903	8021
TP 10	0073318	WIRE 22 BUS	70903	8021
TP 11	0073318	WIRE 22 BUS	70903	8021
U 1	0086633	IC ECL LINE RECEIVER QUAD		MC10115L
U 2	0089656	IC ECL GATE EX OR/NOR 2-IN TRIPLE		F10107DC
U 3	0089653	IC ECL GATE AND 2-IN QUAD 3AND-1AND/NAND		F10104DC
U 4	0089659	IC ECL FLIP-FLOP TYPE-JK DUAL MASTR/SLAV		F10135DC
U 5	0088406	IC ECL FLIP-FLOP TYPE-D 160MHZ M/S DUAL		F10131DC
U 6	0089652	IC ECL GATE OR 2-IN QUAD 3 OR-1 OR/NOR		F10103DC
U 7	0087646	IC ECL COUNTER 4-BIT BINARY 200MHZ		F10016DC
U 8	0087646	IC ECL COUNTER 4-BIT BINARY 200MHZ		F10016DC
U 9	0089653	IC ECL GATE AND 2-IN QUAD 3AND-1AND/NAND		F10104DC
U 10	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR		F10102DC
U 11	0087646	IC ECL COUNTER 4-BIT BINARY 200MHZ		F10016DC
U 12	0087646	IC ECL COUNTER 4-BIT BINARY 200MHZ		F10016DC
U 13	0087646	IC ECL COUNTER 4-BIT BINARY 200MHZ		F10016DC
U 14	0089655	IC ECL GATE NOR 4/3/3-IN TRIPLE		F10106DC
U 15	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR		F10102DC
U 16	0089654	IC ECL GATE NOR/OR 2/3/2-IN TRIPLE		F10105DC
U 17	0088405	IC ECL TRANSLATOR ECL/TTL QUAD		F10125DC

M-FRAME SYNCHRONIZER ASSEMBLY - 220885

REF DESIG PREFIX: 4657-A4

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	05397	T362D107K020AS
C 2	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 3	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	05397	T362D107K020AS
C 4	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 5	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 6	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 7	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 8	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 9	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 10	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 11	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 12	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 13	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 14	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 15	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 16	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
R 1	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 2	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 3		NOT ASSIGNED		
R 4	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 5		NOT ASSIGNED		
R 6	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 7	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 8	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 9	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 10	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 11	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 12	0071897	RESISTOR 150 OHM 1/4W 10% COMP	01121	RCR07G151KS
R 13	0071913	RESISTOR 270 OHM 1/4W 10% COMP	01121	RCR07G271KS
R 14	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 15	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 16	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 17	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 18	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 19	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 20	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 21	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 22	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 23	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 24	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 25	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 26	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 27		NOT ASSIGNED		
R 28	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 29	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 30	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 31	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 32	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 33	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 34	0071913	RESISTOR 270 OHM 1/4W 10% COMP	01121	RCR07G271KS
R 35	0071897	RESISTOR 150 OHM 1/4W 10% COMP	01121	RCR07G151KS
R 36	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 37	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 38	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 39	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 40	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 41	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 42	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 43	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 44	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 45	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 46	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 47	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 48	0071941	RESISTOR 820 OHM 1/4W 10% COMP	01121	RCR07G821KS

M-FRAME SYNCHRONIZER ASSEMBLY - 220885

REF DESIG PREFIX: 4657-A4

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
R 49	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 50	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 51	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 52	0071966	RESISTOR 1.5K OHM 1/4W 10% COMP	01121	RCR07G152KS
R 53	0071913	RESISTOR 270 OHM 1/4W 10% COMP	01121	RCR07G271KS
R 54	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 55	0071879	RESISTOR 82 OHM 1/4W 10% COMP	01121	RCR07G820KS
R 56	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
U 1	0089662	IC ECL REGISTER 4-BIT SHIFT		F10141DC
U 2	0089662	IC ECL REGISTER 4-BIT SHIFT		F10141DC
U 3	0089661	IC ECL COUNTER DECADE 200-MHZ		F10137DC
U 4	0089662	IC ECL REGISTER 4-BIT SHIFT		F10141DC
U 5	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR		F10102DC
U 6	0089656	IC ECL GATE EX OR/NOR 2-IN TRIPLE		F10107DC
U 7	0089652	IC ECL GATE OR 2-IN QUAD 3 OR-1 OR/NOR		F10103DC
U 8	0089659	IC ECL FLIP-FLOP TYPE-JK DUAL MASTR/SLAV		F10135DC
U 9	0088406	IC ECL FLIP-FLOP TYPE-D 160MHZ M/S DUAL		F10131DC
U 10	0089653	IC ECL GATE AND 2-IN QUAD 3AND-1AND/NAND		F10104DC
U 11	0089659	IC ECL FLIP-FLOP TYPE-JK DUAL MASTR/SLAV		F10135DC
U 12	0089653	IC ECL GATE AND 2-IN QUAD 3AND-1AND/NAND		F10104DC
U 13	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR		F10102DC
U 14	0086633	IC ECL LINE RECEIVER QUAD		MC10115L
U 15	0088405	IC ECL TRANSLATOR ECL/TTL QUAD		F10125DC

PSEUDO RANDOM BIT SEQUENCE GEN ASSEMBLY - 310991

REF DESIG PREFIX: 4657-A5

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 2	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 3	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 4	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 5	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 6	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 7	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 8	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 9	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 10	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 11	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 12	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 13	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 14	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 15	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 16	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 17	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 18	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 19	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 20	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 21	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	05397	T362D107K020AS
C 22	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	05397	T362D107K020AS
C 23	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 24	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
CR 1	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 2	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 3	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 4	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
Q 1	0077147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
Q 2	0077147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
R 1	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 2	0071879	RESISTOR 82 OHM 1/4W 10% COMP	01121	RCR07G820KS
R 3	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 4	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 5	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 6	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 7	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 8	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 9	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 10	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 11	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 12	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 13	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 14	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 15	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 16	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 17	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 18	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 19	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 20	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 21	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 22	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 23	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 24	0071966	RESISTOR 1.5K OHM 1/4W 10% COMP	01121	RCR07G152KS
R 25	0071913	RESISTOR 270 OHM 1/4W 10% COMP	01121	RCR07G271KS
R 26	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 27	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 28	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 29	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 30	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 31	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 32	0072077	RESISTOR 47K OHM 1/4W 10% COMP	01121	RCR07G473KS
R 33	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 34	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 35	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS

PSEUDO RANDOM BIT SEQUENCE GEN ASSEMBLY - 310991

REF DESIG PREFIX: 4657-A5

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
R 36	0071918	RESISTOR 331 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 37	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 38	0071966	RESISTOR 1.5K OHM 1/4W 10% COMP	01121	RCR07G152KS
R 39	0071913	RESISTOR 270 OHM 1/4W 10% COMP	01121	RCR07G271KS
R 40	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 41	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 42	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 43	0071926	RESISTOR 470 OHM 1/4W 10% COMP	01121	RCR07G471KS
R 44	0071920	RESISTOR 390 OHM 1/4W 10% COMP	01121	RCR07G391KS
R 45	0071920	RESISTOR 390 OHM 1/4W 10% COMP	01121	RCR07G391KS
R 46	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 47	0071876	RESISTOR 68 OHM 1/4W 10% COMP	01121	RCR07G680KS
R 48	0071920	RESISTOR 390 OHM 1/4W 10% COMP	01121	RCR07G391KS
R 49	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 50	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 51	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 52	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 53	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 54	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 55	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 56	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 57	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 58	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 59	0071876	RESISTOR 68 OHM 1/4W 10% COMP	01121	RCR07G680KS
R 60	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 61	0072054	RESISTOR 22K OHM 1/4W 10% COMP	01121	RCR07G223KS
R 62	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 63	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 64	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 65	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 66	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 67	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
TP 1	0073318	WIRE 22 BUS	70903	8021
U 1	0087646	IC ECL COUNTER 4-BIT BINARY 200MHZ		F10016DC
U 2	0088406	IC ECL FLIP-FLOP TYPE-D 160MHZ M/S DUAL		F10131DC
U 3	0089662	IC ECL REGISTER 4-BIT SHIFT		F10141DC
U 4	0089662	IC ECL REGISTER 4-BIT SHIFT		F10141DC
U 5	0089662	IC ECL REGISTER 4-BIT SHIFT		F10141DC
U 6	0089662	IC ECL REGISTER 4-BIT SHIFT		F10141DC
U 7	0089653	IC ECL GATE AND 2-IN QUAD 3AND-1AND/NAND		F10104DC
U 8	0089656	IC ECL GATE EX OR/NOR 2-IN TRIPLE		F10107DC
U 9	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR		F10102DC
U 10	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR		F10102DC
U 11	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR		F10102DC
U 12	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR		F10102DC
U 13	0089651	IC ECL GATE NOR 2-IN QUAD 3 OR-1 OR/NOR		F10102DC
U 14	0089660	IC ECL COUNTER 4-BIT BINARY 200-MHZ		F10136DC
U 15	0089660	IC ECL COUNTER 4-BIT BINARY 200-MHZ		F10136DC
U 16	0089660	IC ECL COUNTER 4-BIT BINARY 200-MHZ		F10136DC
U 17	0087867	IC TTL MULTI MONO RETRIG DUAL		SN74LS123J
U 18	0089659	IC ECL FLIP-FLOP TYPE-JK DUAL MASTR/SLAV		F10135DC
U 19	0086633	IC ECL LINE RECEIVER QUAD		MC10115L

ERROR COUNTER 1 EXTERNAL EVENT MONITOR ASSEMBLY - 252866

REF DESIG PREFIX: 4657-A6

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
	0252864	ERROR COUNTER 1/EXT EVENT MON SCHEM		
A1	0252865	PWB ERROR COUNTER 1/EXT EVENT MON		
C 001	0C8121C	CAPACITR .C1 MF 5CV CER MCNC X7R 1C%	72982	8121-050-X7R-103K
C 002	0C8121C	CAPACITR .C1 MF 5CV CER MCNC X7R 1C%	72982	8121-050-X7R-103K
C 003	0C8121C	CAPACITR .01 MF 50V CER MCNC X7R 1C%	72982	8121-C5C-X7R-103K
C 004	0C8121C	CAPACITR .C1 MF 5CV CER MCNC X7R 1C%	72982	8121-050-X7R-103K
C 005	0C8121C	CAPACITR .C1 MF 5CV CER MCNC X7R 1C%	72982	8121-050-X7R-103K
C 006	0C8121C	CAPACITR .01 MF 50V CER MCNC X7R 1C%	72982	8121-C5C-X7R-103K
C 007	0C8121C	CAPACITR .C1 MF 5CV CER MCNC X7R 1C%	72982	8121-050-X7R-103K
C 008	0C8121C	CAPACITR .C1 MF 5CV CER MCNC X7R 1C%	72982	8121-050-X7R-103K
C 009	0C8121C	CAPACITR .C1 MF 50V CER MCNC X7R 1C%	72982	8121-C5C-X7R-103K
C 010	0C8121C	CAPACITR .C1 MF 5CV CER MCNC X7R 1C%	72982	8121-050-X7R-103K
C 011	0C8121C	CAPACITR .01 MF 5CV CER MCNC X7R 1C%	72982	8121-050-X7R-103K
C 012	0C8121C	CAPACITR .01 MF 50V CER MCNC X7R 1C%	72982	8121-C5C-X7R-103K
C 013	0C8121C	CAPACITR .C1 MF 5CV CER MCNC X7R 1C%	72982	8121-050-X7R-103K
C 014	0C8121C	CAPACITR .C1 MF 5CV CER MCNC X7R 1C%	72982	8121-050-X7R-103K
C 015		NOT ASSIGNED		
C 016	0C8C139	CAPACITR .1 MF 5CV CER MCNC -20%+80%	72982	8131-C5C-651-104Z
C 017	0C80139	CAPACITR .1 MF 5CV CER MCNC -20%+80%	72982	8131-050-651-104Z
C 018	0C81995	CAPACITR .001 MF 100V CER MCNC X7R 1C%	72982	8121-1C0-X7R-102K
C 019	0C8C139	CAPACITR .1 MF 5CV CER MCNC -20%+80%	72982	8131-C5C-651-104Z
C 020	0C80139	CAPACITR .1 MF 5CV CER MCNC -20%+80%	72982	8131-050-651-104Z
C 021	0C80139	CAPACITR .1 MF 5CV CER MCNC -20%+80%	72982	8131-C5C-651-104Z
C 022	0C8C139	CAPACITR .1 MF 5CV CER MCNC -20%+80%	72982	8131-C5C-651-104Z
C 023	0C80139	CAPACITR .1 MF 5CV CER MCNC -20%+80%	72982	8131-050-651-104Z
C 024	0C87126	CAPACITR 1 MF 100V MET POLYESTER 10%		B32571-1/1C/1C0
C 025	0C87126	CAPACITR 1 MF 100V MET POLYESTER 10%		B32571-1/1C/1CC
C 026	0C80139	CAPACITR .1 MF 5CV CER MCNC -20%+80%	72982	8131-050-651-104Z
C 027	0C87126	CAPACITR 1 MF 100V MET POLYESTER 10%		B32571-1/1C/1C0
C 028	0C8C139	CAPACITR .1 MF 5CV CER MCNC -20%+80%	72982	8131-C5C-651-104Z
C 029	0C8C139	CAPACITR .1 MF 5CV CER MCNC -20%+80%	72982	8131-050-651-104Z
C 030	0C80139	CAPACITR .1 MF 5CV CER MCNC -20%+80%	72982	8131-C5C-651-104Z
C 031	0C811C1	CAPACITR 1 MF 50V CER MCNC 20%	72982	8131-C5C-651-1C5M
C 032	0C8121C	CAPACITR .C1 MF 5CV CER MCNC X7R 1C%	72982	8121-050-X7R-103K
C 033	0D70544	CAPACITR .001 MF 1KV CER DISC Z5F 1C%	71590	CC102
CR001	0C71142	DIODE 1N4154 SIL 25V 150MA	8C368	1N4154
CR002	0C71142	DIODE 1N4154 SIL 25V 150MA	8C368	1N4154
CR003	0C71142	DIODE 1N4154 SIL 25V 150MA	8C368	1N4154
CR004	0C71142	DIODE 1N4154 SIL 25V 150MA	8C368	1N4154
J 001	0D84585	CONN HEADER DBL ROW RT ANGLE 1C-PIN PC	00779	8723C-5
L 001	0C79926	INDUCTOR 1C UH SUBMIN UNSHLD 10%	91637	IR-2
L 002	0C79926	INDUCTOR 1C UH SUBMIN UNSHLD 10%	91637	IR-2
L 003	0C79926	INDUCTOR 1C UH SUBMIN UNSHLD 10%	91637	IR-2
Q 001	0D83032	TRANSSTR 2N2222A NPN SIL		2N2222A
Q 002	0C81544	TRANSSTR 2N4856 SIL FET N-CHNL JUNC	01295	2N4856
Q 003	0C81544	TRANSSTR 2N4856 SIL FET N-CHNL JUNC	01295	2N4856
R 001	0D71879	RESISTOR 82 OHM 1/4W 10% COMP	01121	RCR07G820KS
R 002	0C71894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 003	0C71879	RESISTOR 82 OHM 1/4W 10% COMP	01121	RCR07G820KS
R 004	0D71894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 005	0C71879	RESISTOR 82 OHM 1/4W 10% COMP	01121	RCR07G820KS
R 006	0D71894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 007	0D71879	RESISTOR 82 OHM 1/4W 10% COMP	01121	RCR07G820KS
R 008	0D71894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 009	0C71977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 010	0D71985	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 011	0D72026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 012	0C71977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 013	0D71913	RESISTOR 270 OHM 1/4W 10% COMP	01121	RCR07G271KS
R 014	0D71977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 015	0C71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS

ERROR COUNTER 1 EXTERNAL EVENT MONITOR ASSEMBLY - 252866

REF DESIG PREFIX: 4657-A6

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
R 016	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 017	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 018	0071907	RESISTOR 220 OHM 1/4W 10% COMP	C1121	RCR07C221KS
R 019	0078600	NOT ASSIGNED		
R 020	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	01121	RCR07GE22KS
R 021	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	C1121	RCR07G472KS
R 022	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	01121	RCR07G822KS
R 023	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	01121	RCR07GE22KS
R 024	0083902	RESISTOR 3.01K OHM RN55C 1% MTL FLM		RN55C3011F
R 025	0171582	RESISTOR 49.9K OHM RN55C		RN55C4992E
R 026	0171582	RESISTOR 49.9K OHM RN55C		RN55C4992B
R 027	0071887	RESISTOR 100 OHM 1/4W 10% COMP	GI121	RCR07G101KS
R 028	0171582	RESISTOR 49.9K OHM RN55C		RN55C4992E
R 029	0171582	RESISTOR 49.9K OHM RN55C		RN55C4992B
R 030	0071887	RESISTOR 100 OHM 1/4W 10% COMP	C1121	RCR07G101KS
R 031	0078929	RESISTOR 1.00K OHM RN55C 1% MTL FLM		RN55C1001F
R 032	0089522	POT 100K OHM 1/2W CER 3/8 SQ VER ADJ 25T		3299W-1-104
R 033	0078929	RESISTOR 1.00K OHM RN55C 1% MTL FLM		RN55C1001F
R 034	0083891	RESISTOR 1.50K OHM RN55C 1% MTL FLM		RN55C1501F
R 035	0083929	RESISTOR 30.1K OHM RN55C 1% MTL FLM		RN55C3012F
R 036	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	C1121	RCR07GE22KS
R 037	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	C1121	RCR07GE22KS
R 038	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	01121	RCR07G822KS
R 039	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	C1121	RCR07G472KS
R 040	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	C1121	RCR07GE22KS
R 041	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 042	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	C1121	RCR07GE22KS
R 043	0084873	RESISTOR 14.3K OHM RN55C 1% MTL FLM		RN55C1432F
R 044	0083914	RESISTOR 8.66K OHM RN55C 1% MTL FLM		RN55C8661F
R 045	0071887	RESISTOR 100 OHM 1/4W 10% COMP	C1121	RCR07G101KS
R 046	0071887	RESISTOR 100 OHM 1/4W 10% COMP	C1121	RCR07G101KS
R 047	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 048	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	C1121	RCR07G222KS
R 049	0071985	RESISTOR 3.3K OHM 1/4W 10% COMP	C1121	RCR07G332KS
R 050	0079744	RESISTOR 7.5K OHM RN55C 1% MTL FLM		RN55C7501F
R 051	0087839	POT 5K OHM 1/2W CER 3/8 SQ VERT ADJ 25T		3299W-1-502
U 001	0088405	IC ECL TRANSLATER ECL/TTL QUAD		F10125DC
U 002	0089665	IC TTL COUNTER BIN 90-MHZ		93S16DC
U 003	0089665	IC TTL COUNTER BIN 90-MHZ		93S16DC
U 004	0089665	IC TTL COUNTER BIN 90-MHZ		93S16DC
U 005	0089666	IC TTL FLIP-FLOP TYPE-D OCTAL 3-STATE		SN74S374J
U 006	0089666	IC TTL FLIP-FLOP TYPE-D OCTAL 3-STATE		SN74S374J
U 007	0087693	IC TTL FLIP-FLOP TYPE-D DUAL		SN74S74J
U 008	0084831	IC TTL COUNTER DECADE 90-MHZ	13715	93S10DC
U 009	0081797	IC TTL COUNTER DECADE 50-MHZ 2X5	C1295	SN74196N
U 010	0089527	IC TTL COUNTER DECADE 35-MHZ 2X5 DUAL		SN74LS395N
U 011	0089527	IC TTL COUNTER DECADE 35-MHZ 2X5 DUAL		SN74LS395N
U 012	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
U 013	0170207	IC TTL GATE OR 2-IN QUAD		74F32PC
U 014	0089667	IC TTL GATE NAND 2-IN QUAD OPEN COL		SN74SC3J
U 015	0083240	IC COMPARATOR-VOLTAGE 14L-DIP QUAD	12040	LM339N
U 016	0170249	IC OP AMP 8L-DIP 700 COMP LC OFFSET		OP-07CP
U 017	0171576	IC A/D CONVERTER 4 1/2 DIGIT DUAL SLOPE		TL500C
U 018	0171580	IC DIGITAL PROCESSOR W/H ECC DRIVERS		TL503CN
U 019	0171579	IC VOLTAGE REFERENCE 5.0V		MC1404AL5
U 020	0084509	IC TTL MULTIPLEXER 8-BIT/1-CHNL TRI STE	C1295	SN74LS251N
U 021	0085527	IC TTL COUNTER DECADE 35-MHZ 2X5 DUAL		SN74LS395N
U 022	0087889	IC TTL FLIP-FLOP TYPE-D OCTAL 3-STATE		SN74LS374N
U 023	0084281	IC TTL GATE INVERTER HEX	C1295	SN74LS04N
U 024	0085590	RESISTOR NETWORK 5 4.7K OHM 2% 6 SIP		4306R-101-472
U 025	0089590	RESISTOR NETWORK 5 4.7K OHM 2% 6 SIP		4306R-101-472
U 026	0084280	IC TTL GATE NOR 2-IN QUAD	C1295	SN74LS02N
U 027	0087981	IC TTL BUFFER QUAD 3-STATE		SN74LS125N
U 028	0083806	IC TIMER 8L-DIP	18324	NE555N

ERROR COUNTERS 2 AND 3 ASSEMBLY - 252917

REF DESIG PREFIX: 4657-A7

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 2	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 3	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 4	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 5	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 6	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 7	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	05397	T362D107K020AS
C 8	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 9	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 10	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 11	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 12	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 13	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 14	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 15	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 16	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 17	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 18	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	05397	T362D107K020AS
C 19	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
CR 1	0071110	DIODE 1N277 GER 100V 75MA	80368	1N277
J 1	0087018	CONN COAX SMB MALE PC MT RT ANGLE 75 OHM		51-153-0000
J 2	0087018	CONN COAX SMB MALE PC MT RT ANGLE 75 OHM		51-153-0000
J 3	0087891	CONN HEADER DBL ROW STRAIGHT 12-PIN PC		87227-6
P 2	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
P 3	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
P 4	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
P 5	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
P 6	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
P 7	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
R 1	0071894	RESISTOR 120 OHM 1/4W 10% COMP	01121	RCR07G121KS
R 2	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 3	0071897	RESISTOR 150 OHM 1/4W 10% COMP	01121	RCR07G151KS
R 4		NOT ASSIGNED		
R 5	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 6	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 7	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 8	0074711	RESISTOR 2.7K OHM 1/4W 5% COMP	01121	RCR07G272JS
R 9	0074714	RESISTOR 3.3K OHM 1/4W 5% COMP	01121	RCR07G332JS
R 10	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 11	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
U 1	0089665	IC TTL COUNTER BIN 90-MHZ		93S16DC
U 2	0089665	IC TTL COUNTER BIN 90-MHZ		93S16DC
U 3	0089665	IC TTL COUNTER BIN 90-MHZ		93S16DC
U 4	0089665	IC TTL COUNTER BIN 90-MHZ		93S16DC
U 5	0089665	IC TTL COUNTER BIN 90-MHZ		93S16DC
U 6	0081799	IC TTL GATE NAND 2-IN QUAD	01295	SN74S00N
U 7	0087694	IC TTL BUFFER NAND 4-IN DUAL		SN74S140J
U 8	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
U 9	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
U 10	0089666	IC TTL FLIP-FLOP TYPE-D OCTAL 3-STATE		SN74S374J
U 11	0089666	IC TTL FLIP-FLOP TYPE-D OCTAL 3-STATE		SN74S374J
U 12	0089666	IC TTL FLIP-FLOP TYPE-D OCTAL 3-STATE		SN74S374J
U 13	0085948	IC TTL FLIP-FLOP TYPE-D OCTAL		SN74LS377N
U 14	0085949	IC TTL BUFFER OCTAL 3-STAIE		SN74LS244N
U 15	0086898	IC BUS TRANSCVR 8-BIT		SN74LS245N
U 16	0088405	IC ECL TRANSLATOR ECL/TTL QUAD		F10125DC
U 17	0087093	RESISTOR NETWORK 7 22K OHM 2% 8 SIP		4308R-101-223
U 18	0087694	IC TTL BUFFER NAND 4-IN DUAL		SN74S140J

REAL-TIME CLOCK ASSEMBLY - 304256

REF DESIG PREFIX: 4657-A9

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
2	0304257	- EPROM AND LABEL ASSY RTC EE MON MOL 4657		495-04
BT 1	0C89604	BATTERY NICKEL-CADMIUM 3.6V 70 MA HRS		4C5333-CC3
C 1	0083649	CAPACITR 7-25 PF MIN CER DISC PC MT	72982	538-011-B-7-25
C 2	0080142	CAPACITR 20 PF 500V SILVER MICA 5%	14655	CD15EC200JC3
C 4	0C8121C	CAPACITR .01 MF 50V CER MONC X7R 10%	72982	8121-050-X7R-103K
C 5	0084221	CAPACITR .022 MF 100V CER MONC X7R 10%	72982	8131-100-X7R-223K
C 6	0C818C8	CAPACITR 2.2 MF 50V CER MONO 20%	72982	8141-C5C-651-225M
C 7	0C81101	CAPACITR 1 MF 50V CER MONC 20%	72982	8131-050-651-1C5M
C 8	0035656	CAPACITR 100 MF 20V SOLID TANT POL 10%	05397	T362D107KG2CAS
C 9	0080139	CAPACITR .1 MF 50V CER MONC -20%+80%	72982	8131-C5C-651-1C4Z
C 10	0080139	CAPACITR .1 MF 50V CER MONC -20%+80%	72982	8131-050-651-1C4Z
C 11	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-1C4Z
C 12	0080139	CAPACITR .1 MF 50V CER MONC -20%+80%	72982	8131-C5C-651-1C4Z
C 13	0080139	CAPACITR .1 MF 50V CER MONC -20%+80%	72982	8131-050-651-1C4Z
C 14	0080139	CAPACITR .1 MF 50V CER MONC -20%+80%	72982	8131-050-651-1C4Z
C 15	0080139	CAPACITR .1 MF 50V CER MONC -20%+80%	72982	8131-050-651-1C4Z
C 16	0080139	CAPACITR .1 MF 50V CER MONC -20%+80%	72982	8131-C5C-651-1C4Z
C 17	0080139	CAPACITR .1 MF 50V CER MONC -20%+80%	72982	8131-050-651-1C4Z
C 18	0080139	CAPACITR .1 MF 50V CER MONC -20%+80%	72982	8131-050-651-1C4Z
C 19	0080139	CAPACITR .1 MF 50V CER MONC -20%+80%	72982	8131-C5C-651-1C4Z
C 20	0080139	CAPACITR .1 MF 50V CER MONC -20%+80%	72982	8131-050-651-1C4Z
C 21	0C35654	CAPACITR 10 MF 25V SOLID TANT POL 10%	05397	T362B106KC25AS
C 22	0C7047C	CAPACITR 10 PF 500V SILVER MICA 5%	14655	CD15CD100JC3
CR 1	0083983	DIODE 1N5226B SI ZEN 3.3V 5% .5W	13715	1N5226B
CR 2	0071122	DIODE 1N914 SIL 75V 75MA	80C6B	1N914
CR 3	0071122	DIODE 1N914 SIL 75V 75MA	E0368	1N914
J 2	0C87229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC		8722C-2
J 4	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC		8722C-3
J 6		NOT ASSIGNED		
J 8	0C87229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC	AMP	8722C-2
P 2	0086884	JUMPER FEMALE INSULATED .1C SPACING	BGE	65474-004
P 3	0086884	JUMPER FEMALE INSULATED .1C SPACING	BGE	65474-CC4
P 5	0086884	JUMPER FEMALE INSULATED .1C SPACING	BGE	65474-004
Q 1	0C77147	TRANSSTR 2N3947 NPN SIL	C4713	2N3947
Q 2	0C77147	TRANSSTR 2N3947 NPN SIL	C4713	2N3947
Q 3	0077147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
Q 4	0C77147	TRANSSTR 2N3947 NPN SIL	C4713	2N3947
Q 5	0C77148	TRANSSTR 2N3251 PNP SIL	C4713	2N3251
Q 6	0077147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
Q 7	0077148	TRANSSTR 2N3251 PNP SIL	C4713	2N3251
Q 8	0077147	TRANSSTR 2N3947 NPN SIL	C4713	2N3947
R 1	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G1C2KS
R 2	0C71977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 3	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 5	0071857	RESISTOR 150 OHM 1/4W 10% COMP	01121	RCR07G151KS
R 7	0C72026	RESISTOR 10K OHM 1/4W 10% COMP	C1121	RCR07G1C3KS
R 8	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 9	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G1C3KS
R 11	0C72026	RESISTOR 10K OHM 1/4W 10% COMP	C1121	RCR07G1C3KS
R 12	0072165	RESISTOR 470K OHM 1/4W 10% COMP	01121	RCR07G474KS
R 13	0C81341	RESISTOR 22 MEG 1/4W 10% COMP	C1121	RCR07G226KS
R 14	0C72026	RESISTOR 10K OHM 1/4W 10% COMP	C1121	RCR07G103KS
R 17	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 18	0C72026	RESISTOR 10K OHM 1/4W 10% COMP	C1121	RCR07G1C3KS
R 19	0C72014	RESISTOR 6.8K OHM 1/4W 10% COMP	01121	RCR07G682KS
R 21	0072153	RESISTOR 330K OHM 1/4W 10% COMP	C1121	RCR07G334KS
R 22	0072189	RESISTOR 1.0 MEG 1/4W 10% COMP	01121	RCR07G1C5KS
R 23	0C72147	RESISTOR 270K OHM 1/4W 10% COMP	01121	RCR07G274KS
R 24	0072026	RESISTOR 10K OHM 1/4W 10% COMP	C1121	RCR07G103KS

REAL-TIME CLOCK ASSEMBLY - 304256

REF DESIG PREFIX: 4657-A9

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
R 26	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 27	0072189	RESISTOR 1.0 MEG 1/4W 10% COMP	01121	RCR07G105KS
R 28	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 29	0072054	RESISTOR 22K OHM 1/4W 10% COMP	01121	RCR07G223KS
R 30	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 31	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 32	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 33	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 34	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 35	0074675	RESISTOR 100 OHM 1/4W 5% COMP	01121	RCR07G101JS
R 36	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 37	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 38	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 39	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 40	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 41	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 42	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 43	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 44	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 45	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
RT 1	0083617	THERMSTR 100 OHM DISC 25 DEG C 10%	15801	FD21J1
U 1	0170303	IC CLOCK CALENDAR FOR MICROS CMOS		MM58167N
U 2	0083017	IC CMOS GATE NOR 2-IN QUAD	04713	MC14001BCL
U 3	0086646	IC TTL DECODER 2-BIT TO 1 OF 4 DUAL		SN74LS139N
U 4	0084279	IC TTL GATE NAND 2-IN QUAD	C1295	SN74LS00N
U 5	0084280	IC TTL GATE NOR 2-IN QUAD	01295	SN74LS02N
U 6	0086647	IC TTL GATE AND 2-IN QUAD OPEN COL		SN74LS09N
U 7	0170309	IC CMOS DECODER BCD TO DEC		MM74C42J
U 8	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
U 9	0171581	IC CMOS RAM 2048X8 200 NS STATIC		HM6116L-4
U 13	0085949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U 14	0086898	IC BUS TRANSCVR 8-BIT		SN74LS245N
U 15	0084509	IC TTL MULTIPLEXER 8-BIT/1-CHNL TO1 3STE	C1295	SN74LS251N
U 16	0170205	IC CMOS COUNTER 14 STAGE BIN		CD4060AF
U 17	0084960	IC TTL COUNTER BIN 35-MHZ	01295	SN74LS161AN
U 18	0087804	IC TTL COUNTER BIN 35-MHZ DUAL		SN74LS393J
U 20	0087889	IC TTL FLIP-FLOP TYPE-D OCTAL 3-STATE		SN74LS374N
U 21	0084283	IC TTL FLIP-FLOP TYPE-D DUAL	01295	SN74LS74AN
U 22	0084281	IC TTL GATE INVERTER HEX	C1295	SN74LS04N
U 23	0084285	IC TTL FLIP-FLOP TYPE-D DUAL	C1295	SN74LS74AN
U 24	0087879	IC CMOS MULTI MONO RETRIG DUAL PREC		MC14538BCL
U 25	0087271	IC TIMER 8L-DIP		LM39C5N
XU 1	0086651	SOCKET 24 PIN DIP PC MT		ICT-246-S-T
XU 2	0086648	SOCKET 14 PIN DIP PC MT		ICT-143-S-T
XU 7	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T
XU 9	0086651	SOCKET 24 PIN DIP PC MT		ICT-246-S-T
XU 11	0086652	SOCKET 28 PIN DIP PC MT	RBN	ICT-286-S-TG30
XU 12	0086652	SOCKET 28 PIN DIP PC MT	RBN	ICT-286-S-TG30
XU 13	0086897	SOCKET 20 PIN DIP PC MT	RBN	ICT-203-S-T
XU 14	0086897	SOCKET 20 PIN DIP PC MT	RBN	ICT-203-S-T
XU 16	0086649	SOCKET 16 PIN DIP PC MT	RBN	ICT-163-S-T
XU 20	0086897	SOCKET 20 PIN DIP PC MT	RBN	ICT-203-S-T
XU 24	0086649	SOCKET 16 PIN DIP PC MT	RBN	ICT-163-S-T
XU 25	0087983	SOCKET 8 PIN DIP PC MT	RBN	ICT-083-S-T
Y 1	0170302	CRYSTAL 32.768 KHZ .003% PARALLEL RES	SNV	CX-1V-32.768KHZ CAL A

8080 CPU ASSEMBLY - 304253

REF DESIG PREFIX: 4657-A10

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
1	0252870	PWB SUBASSY 8080 PROCESSOR 16K ROM		
2	0304254	EPROM AND LABEL ASSY CPU MDL 4657		
C 001	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 002	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 003	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 004	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 005	0086013	CAPACITR 22 MF 25V SOLID TANT PCL 10%		T362C226K025AS
C 006	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 007	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 008	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 009	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 010	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 011	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 012	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 013	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 014	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 015	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 016		NOT ASSIGNED		
C 017	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 018	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 019	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 020	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 021	0077512	CAPACITR 24 PF 500V SILVER MICA 5%	14655	CD15ED240J03
C 022	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 023	0079172	CAPACITR 5.5-18 PF MIN CER DISC PC MT	72982	538-011 A 5.5-18
C 024	0070518	CAPACITR 100 PF 1KV CER DISC 53N 10%	71590	DD-101
C 025	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
J C02	0171549	CONN HEADER DBL ROW RT ANGLE 50-PIN LTCH		3433-12C2
J J07	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC		E722C-3
L 001	0078040	INDUCTOR 3.3 UH SUBMIN UNSHLD 10%	51637	IR-2
L 002	0081977	CORE BEAD FERRITE 7D .260X.125X.375L	78488	57-1555
P 002	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
Q 001	0083712	TRANSSTR 2N5019 FET P-CHNL JUNC	32293	2N5019
R 001	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 003	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 004	0071993	RESISTOR 3.9K OHM 1/4W 10% COMP	01121	RCR07G392KS
R 005	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 011	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 012	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 013	0072113	RESISTOR 100K OHM 1/4W 10% COMP	01121	RCR07G104KS
R 014	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 015	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 016	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 017	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 018	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
U 1	0086519	IC MICROPROCESSOR 8-BIT NMOS IMPROVED		C8080A
U 3	0086641	IC PERIPHERAL INTERFACE PROGRAMMABLE		8255A
U 002	0085188	IC CONTROLLER AND BUS DRIVER FOR 8080A		C8228
U 005	0086652	IC TTL GATE INVERTER HEX		SN74LS05J
U 006	0085187	IC CLOCK GENERATOR FOR 8080A CPU		D8224
U 007	0084281	IC TTL GATE INVERTER HEX	01295	SN74LS04N
U 009	0085950	IC TTL LATCH 8-BIT TRANSPARENT 3-STATE		SN74LS373N
U 010	0085950	IC TTL LATCH 8-BIT TRANSPARENT 3-STATE		SN74LS373N
U 011	0085946	IC TTL GATE NAND 3-IN TRIPLE		SN74LS10N
U 012	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
U 013	0084278	IC TTL GATE NAND 4-IN DUAL	01295	SN74LS20N
U 014	0171581	IC CMOS RAM 2048X8 200 NS STATIC		HM6116L-4
U 015		NOT ASSIGNED		
U 016	0086858	IC BUS TRANSCVR 8-BIT		SN74LS245N
U 017	0084282	IC TTL GATE AND 2-IN QUAD	01295	SN74LS08N
U 018	0084279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N
U 020	0087092	RESISTOR NETWORK 9 22K OHM 2% 10 SIP		4310R-101-223
U 021	0087092	RESISTOR NETWORK 9 22K OHM 2% 10 SIP		4310R-101-223
U 022	0087091	RESISTOR NETWORK 9 1K OHM 2% 10 SIP		4310R-101-102

8080 CPU ASSEMBLY - 304253

REF DESIG PREFIX: 4657-A10

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
[illegible]	0087092	RESISTOR NETWORK 9 22K OHM 2% 10 SIP	BLI	4310R-101-223
[illegible]	0087092	RESISTOR NETWORK 9 22K OHM 2% 10 SIP	BLI	4310R-101-223
[illegible]	0087092	RESISTOR NETWORK 9 22K OHM 2% 10 SIP	BLI	4310R-101-223
[illegible]	0087091	RESISTOR NETWORK 9 1K OHM 2% 10 SIP	BLI	4310R-101-102
XU001	0086653	SOCKET 40 PIN DIP PC MT	RBN	ICT-406-S-T
XU002	0086652	SOCKET 28 PIN DIP PC MT	RBN	ICT-286-S-TG30
XU003	0086653	SOCKET 40 PIN DIP PC MT	RBN	ICT-406-S-T
XU004	0086652	SOCKET 28 PIN DIP PC MT	RBN	ICT-286-S-TG30
XU005	0086648	SOCKET 14 PIN DIP PC MT	RBN	ICT-143-S-T
XU006	0086649	SOCKET 16 PIN DIP PC MT	RBN	ICT-163-S-T
XU007	0086648	SOCKET 14 PIN DIP PC MT	RBN	ICT-143-S-T
XU008	0086897	SOCKET 20 PIN DIP PC MT	RBN	ICT-203-S-T
XU010	0086897	SOCKET 20 PIN DIP PC MT	RBN	ICT-203-S-T
XU011	0086648	SOCKET 14 PIN DIP PC MT	RBN	ICT-143-S-T
XU012	0086649	SOCKET 16 PIN DIP PC MT	RBN	ICT-163-S-T
XU013	0086648	SOCKET 14 PIN DIP PC MT	RBN	ICT-143-S-T
XU014	0086651	SOCKET 24 PIN DIP PC MT	RBN	ICT-246-S-T
XU016	0086897	SOCKET 20 PIN DIP PC MT	RBN	ICT-203-S-T
XU017	0086648	SOCKET 14 PIN DIP PC MT	RBN	ICT-143-S-T
XU018	0086648	SOCKET 14 PIN DIP PC MT	RBN	ICT-143-S-T
XU019	0086652	SOCKET 28 PIN DIP PC MT	RBN	ICT-286-S-TG30
Y 001	0087940	CRYSTAL 18.432 MHZ .0025% SERIES MODE	SEN	SCM 18 HCLDER

MOTHERBOARD ASSEMBLY - 252893

REF DESIG PREFIX: 4657-A11

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
J 1	0171548	CONN HEADER DBL ROW SIGHT 50-PIN + LATCH		3433-2202
J 2	0087034	CONN HEADER DBL ROW STRAIGHT 10-PIN PC		87478-2
J 3	0089673	CONN HEADER SGL ROW STRAIGHT 12-PIN PC		1-85830-2
J 4	0086947	CONN HEADER SGL ROW STRAIGHT 7-PIN PC		87224-7
XA 1	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA 2	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA 3	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA 4	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA 5	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA 6	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA 7	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA 8	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA 9	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA 10	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3

-5.2V/-12V POWER SUPPLY ASSEMBLY - 220905

REF DESIG PREFIX: 4657-A12

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 001	0081099	CAPACITR .0047 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-472K
C 002	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 003	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 004	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 005	0086013	CAPACITR 22 MF 25V SOLID TANT POL 10%		T362C226K025AS
C 006	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 007	0084225	CAPACITR .22 MF 100V CER MONO 20%	72982	8131-100-651-224M
C 008	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 009	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 010	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D191CXXXJ03 5980 PF
C 011	0070518	CAPACITR 100 PF 1KV CER DISC S3N 10%	71590	DD-101
C 012	0089645	CAPACITR 220 MF 60V		673D227H0XJE5C
C 013	0170264	CAPACITR 1 MF 100V CER MONO 651 20%		8141-100-651-105M
C 014	0170264	CAPACITR 1 MF 100V CER MONO 651 20%		8141-100-651-105M
C 015	0089643	CAPACITR 1000 MF 15V		672D108H015ET5C
C 016	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 017	0089644	CAPACITR 1000 MF 20V		673D108H020JE5C
C 018	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 019	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 020	0170263	CAPACITR 100 MF 20V		672D107H020CG5C
C 021	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 022	0081099	CAPACITR .0047 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-472K
C 023	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 024	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D191CXXXJ03 5980 PF
C 025	0070518	CAPACITR 100 PF 1KV CER DISC S3N 10%	71590	DD-101
C 026	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 027	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 028	0170263	CAPACITR 100 MF 20V		672D107H020CG5C
C 029	0080149	CAPACITR 4.7 MF 20V SOLID TANT POL 20%	80183	196D475X0020JE3
C 030	0080149	CAPACITR 4.7 MF 20V SOLID TANT POL 20%	80183	196D475X0020JE3
C 031	0089643	CAPACITR 1000 MF 15V		672D108H015ET5C
C 032	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 033	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 034	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 035	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
CR001	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR002	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR003	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR004	0071121	DIODE 1N821 TC REF 6.2V .01% .4W	04713	1N821
CR005	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR006	0083986	DIODE 1N4746A SI ZEN 18V 5% 1W	04713	1N4746A
CR007	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR008	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR009	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR010	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR011	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR012	0089684	DIODE MR821 SIL 100V 5A FAST REC		MR821
CR013	0171572	THYRISTOR SCR 200PRV 25A RMS		C129B5
CR014	0071121	DIODE 1N821 TC REF 6.2V .01% .4W	04713	1N821
CR015	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR016	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR017	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR018	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR019	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR020	0089679	DIODE 80SQ030 SIL 30V 8A SCHOTTKY		80SQ030
CR021	0082901	LAMP LED GRN .190 DIA .180 LNG 2.3V 20MA	31718	FLV340
CR022	0082901	LAMP LED GRN .190 DIA .180 LNG 2.3V 20MA	31718	FLV340
CR023	0078714	DIODE 1N4744A SI ZEN 15V 5% 1W	04713	1N4744A
CR024	0071143	DIODE 1N4735A SI ZEN 6.2V 5% 1W	04713	1N4735A
CR025	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR026	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
J 001	0087042	CONN RECT PIN HEADER PC BD 10 CIRCUIT		1-380991-0
J 002	0087357	CONN RECT PIN HEADER PC BD 2 CKT BLUE		6-350539-2

-5.2V/-12V POWER SUPPLY ASSEMBLY - 220905

REF DESIG PREFIX: 4657-A12

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
L 001	0078841	INDUCTOR 4,7 MH MIN SHLD ENCAP 10%	72259	WEE-4700
L 002	0089688	INDUCTOR 1,5 UH FERRITE 16,2 A PC MT		3443-04
L 003	0220937	COIL ASSY 650 UHY SER 4650		
L 004	0089683	INDUCTOR 50 UH UNSHLD 10%		6310-6
L 005	0089688	INDUCTOR 1,5 UH FERRITE 16,2 A PC MT		3443-04
L 006	0078841	INDUCTOR 4,7 MH MIN SHLD ENCAP 10%	72259	WEE-4700
L 007	0220936	COIL ASSY 420 UHY SER 4650		
Q 001	0076316	TRANSSTR 2N4036 PNP SIL	79089	2N4036S
Q 002	0084113	TRANSSTR TIP 111 NPN SIL DARLINGTON PAIR	01295	TIP 111
Q 003	0077147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
Q 004	0080007	TRANSSTR 2N2102 NPN SIL	79089	2N2102
Q 005	0077148	TRANSSTR 2N3251 PNP SIL	04713	2N3251
Q 006	0089669	TRANSSTR IRF132 FET N-CHNL MOS POWER		IRF132
Q 007	0081633	TRANSTR MPS-L51 PNP SIL	04713	MPS-L51
Q 008	0077148	TRANSSTR 2N3251 PNP SIL	04713	2N3251
Q 009	0089669	TRANSSTR IRF132 FET N-CHNL MOS POWER		IRF132
Q 010	0080824	TRANSSTR 2N5415 PNP SIL	04713	2N5415
Q 011	0080824	TRANSSTR 2N5415 PNP SIL	04713	2N5415
Q 012	0078214	TRANSSTR 2N5087 PNP SIL	04713	2N5087
R 001	0072040	RESISTOR 15K OHM 1/2W 10% COMP	01121	RCR20G153KS
R 002	0071879	RESISTOR 82 OHM 1/4W 10% COMP	01121	RCR07G820KS
R 003	0071951	RESISTOR 1,0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 004	0071833	RESISTOR 6,8 OHM 1/2W 10% COMP	01121	RCR20G6R8KS
R 005	0078929	RESISTOR 1,00K OHM RN55C 1% MTL FLM		RN55C1001F
R 006	0083889	RESISTOR 1,40K OHM RN55C 1% MTL FLM		RN55C1401F
R 007	0085551	POT 5K OHM 1/2W CER 3/8 SQ HOR ADJ 20T	73138	66XR5K
R 008	0072068	RESISTOR 39K OHM 1/4W 10% COMP	01121	RCR07G393KS
R 009	0071982	RESISTOR 2,7K OHM 1/4W 10% COMP	01121	RCR07G272KS
R 010	0072002	RESISTOR 4,7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 011	0072002	RESISTOR 4,7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 012	0071941	RESISTOR 620 OHM 1/4W 10% COMP	01121	RCR07G621KS
R 013	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 014	0083907	RESISTOR 4,22K OHM RN55C 1% MTL FLM		RN55C4221F
R 015	0071989	RESISTOR 3,3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 016	0074714	RESISTOR 3,3K OHM 1/4W 5% COMP	01121	RCR07G332JS
R 017	0074675	RESISTOR 100 OHM 1/4W 5% COMP	01121	RCR07G101JS
R 018	0087584	RESISTOR ,10 OHM 3W 1%		RS-2C ,10 OHM 1%
R 019	0076396	RESISTOR 1,0 OHM 1/2W 10% COMP	01121	RCR20G1R0KS
R 020	0071827	RESISTOR 4,7 OHM 1W 10% COMP	01121	RCR32G4R7KS
R 021	0071951	RESISTOR 1,0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 022	0078931	RESISTOR 4,99K OHM RN55C 1% MTL FLM		RN55C4991F
R 023	0088389	POT 2K OHM 1/2W CER 3/8 SQ HOR ADJ 25T		3299X-1-202
R 024	0076981	RESISTOR 5,90K OHM RN55C 1% MTL FLM		RN55C5901F
R 025	0079085	RESISTOR 100 OHM 3W WW 5%	24681	VAL-3
R 026	0079128	RESISTOR 768 OHM RN55C 1% MTL FLM		RN55C7680F
R 027	0071873	RESISTOR 56 OHM 1/4W 10% COMP	01121	RCR07G560KS
R 028	0072039	RESISTOR 15K OHM 1/4W 10% COMP	01121	RCR07G153KS
R 029	0071973	RESISTOR 1,8K OHM 1/4W 10% COMP	01121	RCR07G182KS
R 030	0085551	POT 5K OHM 1/2W CER 3/8 SQ HOR ADJ 20T	73138	66XR5K
R 031	0072068	RESISTOR 39K OHM 1/4W 10% COMP	01121	RCR07G393KS
R 032	0072002	RESISTOR 4,7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 033	0072002	RESISTOR 4,7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 034	0071973	RESISTOR 1,8K OHM 1/4W 10% COMP	01121	RCR07G182KS
R 035	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 036	0083901	RESISTOR 2,61K OHM RN55C 1% MTL FLM		RN55C2611F
R 037	0071989	RESISTOR 3,3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 038	0074714	RESISTOR 3,3K OHM 1/4W 5% COMP	01121	RCR07G332JS
R 039	0074675	RESISTOR 100 OHM 1/4W 5% COMP	01121	RCR07G101JS
R 040	0087584	RESISTOR ,10 OHM 3W 1%		RS-2C ,10 OHM 1%

-5.2V/-12V POWER SUPPLY ASSEMBLY - 220905

REF DESIG PREFIX: 4657-A12

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
R 041	0071939	RESISTOR 680 OHM 1/2W 10% COMP	01121	RCR20G681KS
R 042	0071862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R 043	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 044	0071939	RESISTOR 680 OHM 1/2W 10% COMP	01121	RCR20G681KS
R 045	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 046	0076275	RESISTOR 22 OHM 1/4W 10% COMP	01121	RCR07G220KS
R 047	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 048	0071951	RESISTOR 1,0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 049	0071989	RESISTOR 3,3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 050	0071867	RESISTOR 50 OHM 3W WW 5%	24681	VAL3
R 051	0083038	RESISTOR 6,81K OHM RN55C 1% MTL FLM		RN55C6811F
R 052	0079104	RESISTOR 5,36K OHM RN55C 1% MTL FLM		RN55C5361F
R 053	0072039	RESISTOR 15K OHM 1/4W 10% COMP	01121	RCR07G153KS
R 054	0071857	RESISTOR 33 OHM 1/4W 10% COMP	01121	RCR07G330KS
R 055	0072019	RESISTOR 8,2K OHM 1/4W 10% COMP	01121	RCR07G822KS
R 056	0071977	RESISTOR 2,2K OHM 1/4W 10% COMP	01121	RCR07G222KS
TP001	0082909	TERMINAL PRESS MT DISCONNECT ,058 PIN	00779	60599-1
TP002	0082909	TERMINAL PRESS MT DISCONNECT ,058 PIN	00779	60599-1
TP003	0082909	TERMINAL PRESS MT DISCONNECT ,058 PIN	00779	60599-1
TP004	0082909	TERMINAL PRESS MT DISCONNECT ,058 PIN	00779	60599-1
TP005	0082909	TERMINAL PRESS MT DISCONNECT ,058 PIN	00779	60599-1
U 001	0085993	IC VLTG RGLTR/PW MOD 70C 16L-DIP		SG3524
U 002	0084890	IC OP AMP 8L-DIP 70C COMP 741C	04713	MC1741CP1
U 003	0085993	IC VLTG RGLTR/PW MOD 70C 16L-DIP		SG3524
U 004	0084890	IC OP AMP 8L-DIP 70C COMP 741C	04713	MC1741CP1

+5V/+12V POWER SUPPLY ASSEMBLY - 220917

REF DESIG PREFIX: 4657-A13

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 2	0081098	CAPACITR .47 MF 50V CER MONO 20%	72982	8131-050-651-474M
C 3	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 4	0070552	CAPACITR .002 MF 1KV CER DISC Z5U 20%	71590	DD202
C 5	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D191CXXXJ03 5980 PF
C 6	0070518	CAPACITR 100 PF 1KV CER DISC S3N 10%	71590	DD-101
C 7	0089645	CAPACITR 220 MF 60V		673D227H0XJE5C
C 8	0070552	CAPACITR .002 MF 1KV CER DISC Z5U 20%	71590	DD202
C 9	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 10	0073498	CAPACITR 820 PF 500V SILVER MICA 5%	14655	CD19FD821J03
C 11	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 12	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D191CXXXJ03 5980 PF
C 13	0070518	CAPACITR 100 PF 1KV CER DISC S3N 10%	71590	DD-101
C 14	0082262	CAPACITR .033 MF 50V CER MONO 20%	72982	8121-050-651-333M
C 15	0089643	CAPACITR 1000 MF 15V		672D108H015ET5C
C 16	0080149	CAPACITR 4.7 MF 20V SOLID TANT POL 20%	80183	196D475X0020JE3
C 17	0170264	CAPACITR 1 MF 100V CER MONO 651 20%		8141-100-651-105M
C 18	0086013	CAPACITR 22 MF 25V SOLID TANT POL 10%		T362C226K025AS
C 19	0086013	CAPACITR 22 MF 25V SOLID TANT POL 10%		T362C226K025AS
C 20	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 21	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 22	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 23	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 24	0070552	CAPACITR .002 MF 1KV CER DISC Z5U 20%	71590	DD202
C 25	0170263	CAPACITR 100 MF 20V		672D107H020CG5C
C 26	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 27	0070561	CAPACITR .005 MF 1KV CER DISC Z5U 20%	71590	DD5022
C 28	0089644	CAPACITR 1000 MF 20V		673D108H020JE5C
C 29	0170263	CAPACITR 100 MF 20V		672D107H020CG5C
C 30	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-102K
C 31	0080149	CAPACITR 4.7 MF 20V SOLID TANT POL 20%	80183	196D475X0020JE3
C 32	0170264	CAPACITR 1 MF 100V CER MONO 651 20%		8141-100-651-105M
CR 1	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 2	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 3	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR 4	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR 5	0083986	DIODE 1N4746A SI ZEN 18V 5% 1W	04713	1N4746A
CR 6	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR 7	0171572	THYRISTOR SCR 200PRV 25A RMS		C129B5
CR 8	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 9	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 10	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 11	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 12	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR 13	0089679	DIODE 80SQ030 SIL 30V 8A SCHOTTKY		80SQ030
CR 14	0071143	DIODE 1N4735A SI ZEN 6.2V 5% 1W	04713	1N4735A
CR 15	0071111	DIODE 1N459A SIL 175V 40MA	80368	1N459A
CR 16	0082901	LAMP LED GRN .190 DIA .180 LNG 2.3V 20MA	31718	FLV340
CR 17	0079488	DIODE 1N5302 CURRENT REGULATOR 1.5MA	04713	1N5302
CR 18	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 19	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR 20	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR 21	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR 22	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 23	0089681	RECTIFIER ASSY 200V 10A FAST REC.200 NSC		VJ248X
CR 24	0078714	DIODE 1N4744A SI ZEN 15V 5% 1W	04713	1N4744A
CR 25	0071111	DIODE 1N459A SIL 175V 40MA	80368	1N459A
CR 26	0082901	LAMP LED GRN .190 DIA .180 LNG 2.3V 20MA	31718	FLV340
CR 27	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
J 1	0170255	CONN RECT PIN HEADER PC 10 CIRCUIT RED		1-380991-2
L 1	0078841	INDUCTOR 4.7 MH MIN SHLD ENCAP 10%	72259	WEE-4700
L 2	0220936	COIL ASSY 420 UHY SER 4650		3443-04
L 3	0089688	INDUCTOR 1.5 UH FERRITE 16.2 A PC MT		6310-6
L 4	0220936	COIL ASSY 420 UHY SER 4650		
L 5	0089683	INDUCTOR 50 UH UNSHLD 10%		

+5V/+12V POWER SUPPLY ASSEMBLY - 220917

REF DESIG PREFIX: 4657-A13

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
Q 1	0077148	TRANSSTR 2N3251 PNP SIL	04713	2N3251
Q 2	0089670	TRANSSTR IRF230 FET N-CHNL MOS POWER		IRF230
Q 3	0089670	TRANSSTR IRF230 FET N-CHNL MOS POWER		IRF230
Q 4	0077148	TRANSSTR 2N3251 PNP SIL	04713	2N3251
Q 5	0077148	TRANSSTR 2N3251 PNP SIL	04713	2N3251
Q 6	0089669	TRANSSTR IRF132 FET N-CHNL MOS POWER		IRF132
Q 7	0080824	TRANSSTR 2N5415 PNP SIL	04713	2N5415
Q 8	0081633	TRANSTR MPS-L51 PNP SIL	04713	MPS-L51
Q 9	0081633	TRANSTR MPS-L51 PNP SIL	04713	MPS-L51
Q 10	0078215	TRANSSTR 2N5089 NPN SIL	04713	2N5089
Q 11	0080824	TRANSSTR 2N5415 PNP SIL	04713	2N5415
R 1	0085551	POT 5K OHM 1/2W CER 3/8 SQ HOR ADJ 20T	73138	66XR5K
R 2	0072068	RESISTOR 39K OHM 1/4W 10% COMP	01121	RCR07G393KS
R 3	0083902	RESISTOR 3,01K OHM RN55C 1% MTL FLM		RN55C3011F
R 4	0087193	POT 1K OHM 1/2W CER 3/8 SQ HDR ADJ 20T		MT4Y102
R 5	0083898	RESISTOR 2,15K OHM RN55C 1% MTL FLM		RN55C2151F
R 6	0071993	RESISTOR 3,9K OHM 1/4W 10% COMP	01121	RCR07G392KS
R 7	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 8	0083881	RESISTOR 866 OHM RN55C 1% MTL FLM		RN55C8660F
R 9	0083907	RESISTOR 4,22K OHM RN55C 1% MTL FLM		RN55C4221F
R 10	0074714	RESISTOR 3,3K OHM 1/4W 5% COMP	01121	RCR07G332JS
R 11	0078110	RESISTOR 180 OHM 1/4W 5% COMP	01121	RCR07G181JS
R 12		NOT ASSIGNED		
R 13	0071989	RESISTOR 3,3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 14	0071867	RESISTOR 50 OHM 3W WW 5%	24681	VAL3
R 15	0087584	RESISTOR ,10 OHM 3W 1%		RS-2C ,10 OHM 1%
R 16	0071989	RESISTOR 3,3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 17	0085551	POT 5K OHM 1/2W CER 3/8 SQ HOR ADJ 20T	73138	66XR5K
R 18	0072068	RESISTOR 39K OHM 1/4W 10% COMP	01121	RCR07G393KS
R 19	0083902	RESISTOR 3,01K OHM RN55C 1% MTL FLM		RN55C3011F
R 20	0087193	POT 1K OHM 1/2W CER 3/8 SQ HDR ADJ 20T		MT4Y102
R 21	0083898	RESISTOR 2,15K OHM RN55C 1% MTL FLM		RN55C2151F
R 22	0071951	RESISTOR 1,0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 23	0083901	RESISTOR 2,61K OHM RN55C 1% MTL FLM		RN55C2611F
R 24	0072002	RESISTOR 4,7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 25	0071966	RESISTOR 1,5K OHM 1/4W 10% COMP	01121	RCR07G152KS
R 26	0071867	RESISTOR 50 OHM 3W WW 5%	24681	VAL3
R 27	0076275	RESISTOR 22 OHM 1/4W 10% COMP	01121	RCR07G220KS
R 28	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 29	0071939	RESISTOR 680 OHM 1/2W 10% COMP	01121	RCR20G681KS
R 30	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 31	0072002	RESISTOR 4,7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 32	0071853	RESISTOR 27 OHM 1/4W 10% COMP	01121	RCR07G270KS
R 33	0071853	RESISTOR 27 OHM 1/4W 10% COMP	01121	RCR07G270KS
R 34	0072002	RESISTOR 4,7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 35	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 36	0072064	RESISTOR 33K OHM 1/4W 10% COMP	01121	RCR07G333KS
R 37	0082128	RESISTOR 12,1K OHM RN60C 1% MTL FLM		RN60C1212F
R 38	0071853	RESISTOR 27 OHM 1/4W 10% COMP	01121	RCR07G270KS
R 39	0083902	RESISTOR 3,01K OHM RN55C 1% MTL FLM		RN55C3011F
R 40	0079713	RESISTOR 2,00K OHM RN55C 1% MTL FLM		RN55C2001F
R 41	0083902	RESISTOR 3,01K OHM RN55C 1% MTL FLM		RN55C3011F
R 42	0071831	RESISTOR 5,6 OHM 1/2W 10% COMP	01121	RCR20G5R6KS
R 43	0079085	RESISTOR 100 OHM 3W WW 5%	24681	VAL-3
R 44	0071862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R 45	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 46	0071939	RESISTOR 680 OHM 1/2W 10% COMP	01121	RCR20G681KS
T 1	0220933	TRANSFORMR PWR SWITCHING SER 4650		
TP 1	0076490	JACK TEST BLUE	74970	105-810
TP 2	0076490	JACK TEST BLUE	74970	105-810
TP 3	0076490	JACK TEST BLUE	74970	105-810
TP 4	0076490	JACK TEST BLUE	74970	105-810
U 1	0085993	IC VLTG RGLTR/PW MOD 70C 16L-DIP		SG3524
U 2	0085993	IC VLTG RGLTR/PW MOD 70C 16L-DIP		SG3524
U 3	0086269	IC OP AMP PMOS 8L-TO5 70C COMP		CA3140T
U 4	0083806	IC TIMER 8L-DIP	18324	NE555N

FRONT PANEL ASSEMBLY - 252853

REF DESIG PREFIX: 4657-A14

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
	0158087	BEZEL,SWITCH,MODEL 4647		
	0089611	PUSHBUTTON BLACK FOR SA PN 89610		B305BL
	0089629	PUSHBUTTON RED FOR SA PN 89610		B305RD
	0170260	PUSHBUTTON BLUE FOR SA PN 89610		B305BU
A 1	0255770	PWB ASSY CLOCK DISPLAY RCVR MDL 4657		
A 2	0252888	PWB ASSY ERROR DISPLAY MDL 4657		
A 3	0252899	PWB ASSY FRONT PANEL I/O MDL 4657		
A 4	0252863	PWB ASSY-FR PNL ERR RT ANALYZR MDL 4657		
W 1	0220972	CABLE ASSY DS-3 INPUT MDL 4652		
W 2	0220973	CABLE ASSY NRZ CLOCK INPUT MDL 4652		
W 3	0220974	CABLE ASSY NRZ DATA INPUT MDL 4652		
W 4	0220975	CABLE ASSY X-BIT OUTPUT MDL 4652		
W 5	0220976	CABLE ASSY GAPPED CLOCK OUTPUT MDL 4652		
W 6	0220977	CABLE ASSY DATA OUTPUT MDL 4652		
W 7	0220978	CABLE ASSY M-SYNC OUTPUT MDL 4652		
W 8	0220979	CABLE ASSY ERROR OUTPUT MDL 4652		
W 9	0220980	CABLE ASSY FRONT PNL I/O MDL 4652		

CLOCK DISPLAY ASSEMBLY - 255770

REF DESIG PREFIX: 4657-A14A1

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
A1P 1	0085128	CONN HEADER DBL ROW STRAIGHT 28-PIN PC	00779	1-87227-4
A1P 2	0085128	CONN HEADER DBL ROW STRAIGHT 28-PIN PC	00779	1-87227-4
R 1	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 2	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 3	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 4	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
U 1	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.		HDSP-3733
U 2	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.		HDSP-3733
U 3	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.		HDSP-3733
U 4	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.		HDSP-3733
U 5	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.		HDSP-3733
U 6	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.		HDSP-3733
U 7	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.		HDSP-3733
U 8	0088582	LAMP LED LIGHT BAR 2-SECT RED		HLMP-2300
U 9	0088582	LAMP LED LIGHT BAR 2-SECT RED		HLMP-2300

ERROR DISPLAY ASSEMBLY - 252888

REF DESIG PREFIX: 4657-A14A2

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
A2P 1	0085128	CONN HEADER DBL ROW STRAIGHT 28-PIN PC	00779	1-87227-4
A2P 2	0085128	CONN HEADER DBL ROW STRAIGHT 28-PIN PC	00779	1-87227-4
U 1	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.		HDSP-3733
U 2	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.		HDSP-3733
U 3	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.		HDSP-3733
U 4	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.		HDSP-3733
U 5	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.		HDSP-3733
U 6	0089678	DISPLAY LED 7 SEG RED RHDP .43 IN.		HDSP-3733

FRONT PANEL I/O ASSEMBLY - 252899

REF DESIG PREFIX: 4657-A14A3

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0170208	CAPACITR 5000 MF 10V		10-85-ARD-10-1
C 2	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 3	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 4	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 5	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 6	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 7	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 8	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 9	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 10	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 11	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 12	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 13	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 14	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 15	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
CR 1	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 2	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 3	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 4	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 5	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 6	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 7	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 8	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
J 1	0171871	CONN HEADER DBL ROW STRAIGHT 50-PIN PC		87220-2
J 2	0087229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC		
L 1	0081740	INDUCTOR 250 UH FILTER CHOKE 1.3A	04213	6310-9
P 1	0084930	CONN HEADER DBL ROW STRAIGHT 20-PIN PC	00779	1-87227-0
P 2	0084930	CONN HEADER DBL ROW STRAIGHT 20-PIN PC	00779	1-87227-0
P 3	0085128	CONN HEADER DBL ROW STRAIGHT 28-PIN PC	00779	1-87227-4
P 4	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
Q 1	0083032	TRANSSTR 2N2222A NPN SIL		2N2222A
Q 2	0083032	TRANSSTR 2N2222A NPN SIL		2N2222A
R 1	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 2	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 3	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 4	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 5	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
U 1	0088053	IC INTERFACE CPU TO KEYBOARD AND DISPLAY		P8279-5
U 2	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
U 3	0086205	IC TTL BUFFER INVERT OCTAL 3-STATE		SN74LS240N
U 4	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
U 5	0083621	IC CMOS DECODER BCD TO DEC OR BIN/OCTL	04713	MC14028BCL
U 6	0083621	IC CMOS DECODER BCD TO DEC OR BIN/OCTL	04713	MC14028BCL
U 7		NOT ASSIGNED		
U 8		NOT ASSIGNED		
U 9	0086205	IC TTL BUFFER INVERT OCTAL 3-STATE		SN74LS240N
U 10	0086899	RESISTOR NETWORK 9 3.3K OHM 2% 10 SIP		785-1-R3.3K
U 11	0087800	RESISTOR NETWORK 8 220 OHM 2% 16 DIP		898-3-R220
U 12	0171540	RESISTOR NETWORK 7 470 OHM 2% 8 SIP		4308R-101-471
U 13	0089504	RESISTOR NETWORK 8 3.3K OHM 2% 16 DIP		4116R-001-332
U 14	0089504	RESISTOR NETWORK 8 3.3K OHM 2% 16 DIP		4116R-001-332
U 15	0171541	RESISTOR NETWORK 7 680 OHM 2% 8 SIP		4308R-101-681
U 16	0085948	IC TTL FLIP-FLOP TYPE-D OCTAL		SN74LS377N
U 17	0085948	IC TTL FLIP-FLOP TYPE-D OCTAL		SN74LS377N
U 19	0087800	RESISTOR NETWORK 8 220 OHM 2% 16 DIP		898-3-R220
U 20	0087800	RESISTOR NETWORK 8 220 OHM 2% 16 DIP		898-3-R220
U 21	0087800	RESISTOR NETWORK 8 220 OHM 2% 16 DIP		898-3-R220
U 22	0171539	RESISTOR NETWORK 5 3.3K OHM 2% 6 SIP		4306R-101-332
U 23		NOT ASSIGNED		
U 24		NOT ASSIGNED		
U 26	0085946	IC TTL GATE NAND 3-IN TRIPLE		SN74LS10N

FRONT PANEL ERROR RATE ANALYZER - 252863

REF DESIG PREFIX: 4657-A14A4

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0061101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
CR 1	0171565	LAMP LED YEL .115 DIA .135 LNG 2.2V 10MA		HLMP-1402
CR 2	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 3	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 4	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 5	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 6	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 7	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 8	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 9	0089614	LAMP LED RED .123 DIA .105 LNG 2.0V 20MA		MV5777C
CR 10	0089614	LAMP LED RED .123 DIA .105 LNG 2.0V 20MA		MV5777C
CR 11	0089614	LAMP LED RED .123 DIA .105 LNG 2.0V 20MA		MV5777C
CR 12	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 13	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 14	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 15	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 16	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 17	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 18	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 19	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 20	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 21	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 22	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 23	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 24	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 25	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 26	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 27	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 28	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 29	0171565	LAMP LED YEL .115 DIA .135 LNG 2.2V 10MA		HLMP-1402
CR 30	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 31	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 32	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 33	0171565	LAMP LED YEL .115 DIA .135 LNG 2.2V 10MA		HLMP-1402
CR 34	0171565	LAMP LED YEL .115 DIA .135 LNG 2.2V 10MA		HLMP-1402
CR 35	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 36	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 37	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
CR 38	0089614	LAMP LED RED .123 DIA .105 LNG 2.0V 20MA		MV5777C
DS 1	0252945	HDRN ASSY MDL 4652A		
J 1	0087064	CONN HEADER SGL ROW RT ANGLE 5-PIN PC		E7233-5
Q 1	0083033	TRANSSTR 2N2907A PNP SIL		2N2907A
Q 2	0083033	TRANSSTR 2N2907A PNP SIL		2N2907A
Q 3	0083033	TRANSSTR 2N2907A PNP SIL		2N2907A
Q 4	0083033	TRANSSTR 2N2907A PNP SIL		2N2907A
Q 5	0083033	TRANSSTR 2N2907A PNP SIL		2N2907A
Q 6	0083033	TRANSSTR 2N2907A PNP SIL		2N2907A
Q 7	0083033	TRANSSTR 2N2907A PNP SIL		2N2907A
Q 8	0083033	TRANSSTR 2N2907A PNP SIL		2N2907A
Q 9	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 10	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 11	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 12	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 13	0083033	TRANSSTR 2N2907A PNP SIL		2N2907A
Q 14	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 15	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 16	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 17	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 18	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 19	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 20	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 21	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 22	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 23	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 24	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 25	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 26	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427
Q 27	0084815	TRANSSTR 2N6427 NPN SIL DARLINGTON PAIR	04713	2N6427

FRONT PANEL ERROR RATE ANALYZER - 252863

REF DESIG PREFIX: 4657-A14A4

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
R 1	0076280	RESISTOR 6.8 OHM 1/4W 10% COMP	01121	RCR07G6R8KS
R 2	0076280	RESISTOR 6.8 OHM 1/4W 10% COMP	01121	RCR07G6R8KS
R 3	0076280	RESISTOR 6.8 OHM 1/4W 10% COMP	01121	RCR07G6R8KS
R 4	0076280	RESISTOR 6.8 OHM 1/4W 10% COMP	01121	RCR07G6R8KS
R 5	0076280	RESISTOR 6.8 OHM 1/4W 10% COMP	01121	RCR07G6R8KS
R 6	0076280	RESISTOR 6.8 OHM 1/4W 10% COMP	01121	RCR07G6R8KS
R 7	0076280	RESISTOR 6.8 OHM 1/4W 10% COMP	01121	RCR07G6R8KS
R 8	0076280	RESISTOR 6.8 OHM 1/4W 10% COMP	01121	RCR07G6R8KS
R 9	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G6R8KS
R 10	0071926	RESISTOR 470 OHM 1/4W 10% COMP	01121	RCR07G102KS
R 11	0072113	RESISTOR 100K OHM 1/4W 10% COMP	01121	RCR07G471KS
R 12	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G104KS
R 13	0071913	RESISTOR 270 OHM 1/4W 10% COMP	01121	RCR07G102KS
R 14	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G271KS
			01121	RCR07G103KS
S 1	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 2	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 3	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 4	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 5	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 6	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 7	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 8	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 9	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 10	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 11	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 12	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 13	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 14	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 15	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 16	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 17	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 18	0089610	SWITCH PUSHB DPDT MOM		K40152AA
XA1P1	0084571	CONN 28 PIN FEM DOUBLE ROW BOTTOM MT	00779	86418-3
XA1P2	0084571	CONN 28 PIN FEM DOUBLE ROW BOTTOM MT	00779	86418-3
XA2P1	0084571	CONN 28 PIN FEM DOUBLE ROW BOTTOM MT	00779	86418-3
XA2P2	0084571	CONN 28 PIN FEM DOUBLE ROW BOTTOM MT	00779	86418-3
XA3P1	0085182	CONN 20-PIN FEM DOUBLE ROW BOTTOM MT	00779	86418-1
XA3P2	0085182	CONN 20-PIN FEM DOUBLE ROW BOTTOM MT	00779	86418-1
XA3P3	0084571	CONN 28 PIN FEM DOUBLE ROW BOTTOM MT	00779	86418-3

REAR PANEL ASSEMBLY - 256296

REF DESIG PREFIX: 4657-A15

REF DESIG		PART NO.		DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
	2	0252782		PWR WIRING HARNESS AC/DC BERTS		
	3	0218087	A	COVER, XFORMER MODEL 4647		
	5	0256295	B	SCREEN ASSY MODEL 4650		
	6	0220929		COVER AC SAFETY BERTS SYSTEM SERIES 465C		
	24	0079333		GUARD FINGER FAN	82877	20C49 340
A	1	0252781	C	PWB ASSY RECTIFIER & FILTER AC/DC BERTS		
B	1	0220451		FAN ASSY SERIES 465C		
T	1	0252727		TRANSFORMER,POWER BERTS		

RECTIFIER AND FILTER PCB ASSEMBLY - 252781

REF DESIG PREFIX: 4657-A15A1

REF DESIG		PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C	1	0075417	CAPACITR .01 MF 150V CER DISC Z5V-40+60%	71590	DDM-103
C	2	0089646	CAPACITR 33 MF 100V		672D336H100EK5C
C	3	0089646	CAPACITR 33 MF 100V		672D336H100EK5C
C	4	0171550	CAPACITR 1600 MF 75V		3050HP162U075JM
C	5	0171550	CAPACITR 1600 MF 75V		3050HP162U075JM
C	6	0170264	CAPACITR 1 MF 100V CER MONO 651 20%		8141-100-651-105M
CR	1	0081865	DIODE 1N4999 SIL 200V 3A PC MOUNT	04713	1N4999
CR	2	0089680	RECTIFIER ASSY 200V 10A		PY20-WIRE LEADS
CR	3	0089680	RECTIFIER ASSY 200V 10A		PY20-WIRE LEADS
CR	4	0083986	DIODE 1N4746A SI ZEN 18V 5% 1W	04713	1N4746A
F	1	0071232	FUSE 5 AMP SLO BLO	75915	3AG 313005.
F	2	0071236	FUSE 10 AMP 250 VOLT	75915	3AB 314010.
J	1	0089690	CONN RECT SOCKET HEADER ASSY 3 CIRCUITS		350760-4
J	2	0082769	CONN RECT PIN HEADER PC BD 6 CIRCUIT	00779	1-380999-0
J	3	0087351	CONN RECT PIN HEADER PC BD 2 CIRCUIT		350539-2
L	1	0170266	INDUCTOR 47 UH CHOKE 4 AMPS		RL-1283-47
L	2	0170266	INDUCTOR 47 UH CHOKE 4 AMPS		RL-1283-47
Q	1	0089669	TRANSSTR IRF132 FET N-CHNL MOS POWER		IRF132
R	1	0072214	RESISTOR 4.7 MEG 1/4W 10% COMP	01121	RCR07G475KS

IEEE-488 INTERFACE OPTION ASSEMBLY - 257189

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 001	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 002	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 003	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 004	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 005	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 006	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 007	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-102K
C 008	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-102K
C 009	0084214	CAPACITR .0015 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-152K
C 010	0070544	CAPACITR .001 MF 1KV CER DISC Z5F 10%	71590	DD102
C 011	0077583	CAPACITR 390 PF 1KV CER DISC Z5F 10%	71590	DD391
C 012	0077583	CAPACITR 390 PF 1KV CER DISC Z5F 10%	71590	DD391
C 013	0070515	CAPACITR 120 PF 500V SILVER MICA 5%	14655	CD15FD121J03
J 001		NOT ASSIGNED		
J 002	0089595	CONN HEADER DBL ROW RT ANGLE 24-PIN PC		1-87230-2
J 003	0087229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC		87220-2
L 001	0078716	INDUCTOR 100 UH SUBMIN UNSHLD 10%	91637	IR-2
L 002	0078716	INDUCTOR 100 UH SUBMIN UNSHLD 10%	91637	IR-2
P 001	0086100	PWB PRINTED COMPONENT		
P 002		NOT ASSIGNED		
P 003	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
Q 001	0077147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
Q 002	0077147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
Q 003	0079490	TRANSSTR 2N2369A NPN SIL SWITCHING	79089	2N2369A
Q 004	0079490	TRANSSTR 2N2369A NPN SIL SWITCHING	79089	2N2369A
R 001	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 002	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 003	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 004	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 005	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 006	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 007	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 008	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 009	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 010	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 011	0071993	RESISTOR 3.9K OHM 1/4W 10% COMP	01121	RCR07G392KS
R 012	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 013	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 014	0071966	RESISTOR 1.5K OHM 1/4W 10% COMP	01121	RCR07G152KS
R 015	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 016	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 017	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 018	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 019	0072054	RESISTOR 22K OHM 1/4W 10% COMP	01121	RCR07G223KS
S 001	0083296	SWITCH SPST 8 PCS PC MT DIP	00779	435166-5
U 001	0086901	IC BUS TRANSCVR IEEE 488 INTERFACE		MC3448P
U 002	0086901	IC BUS TRANSCVR IEEE 488 INTERFACE		MC3448P
U 003	0086901	IC BUS TRANSCVR IEEE 488 INTERFACE		MC3448P
U 004	0086901	IC BUS TRANSCVR IEEE 488 INTERFACE		MC3448P
U 005	0084000	VARIES WITH MODEL,SEE HIGHER ASSY FOR PN		
U 006	0085949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U 007	0086898	IC BUS TRANSCVR 8-BIT		SN74LS245N
U 008	0080979	IC TTL BUFFER INVERT HEX OPEN-COL	01295	SN7406N
U 009	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
U 010	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
U 011	0084283	IC TTL FLIP-FLOP TYPE-D DUAL	01295	SN74LS74AN
U 012	0084284	IC TTL GATE NOR 3-IN TRIPLE	01295	SN74LS27N
U 013	0086899	RESISTOR NETWORK 9 3.3K OHM 2% 10 SIP		785-1-R3.3K
U 014	0084279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N
U 015	0085946	IC TTL GATE NAND 3-IN TRIPLE		SN74LS10N

RS-232C INTERFACE OPTION ASSEMBLY - 257190

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 001	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 002	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 003	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 004	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 005	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 006	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 007	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 009	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
J 001	0087031	CONN HEADER DBL ROW RT ANGLE 26-PIN PC		87476-3
R 001	0074722	RESISTOR 4.7K OHM 1/4W 5% COMP	01121	RCR07G472JS
R 002	0074722	RESISTOR 4.7K OHM 1/4W 5% COMP	01121	RCR07G472JS
U 001	0086788	CAPACITR NTWK 7-390PF 100V 10% CER 8 SIP		460CH391X9PD
U 002	0087083	IC DTL LINE DRIVER QUAD		MC1488L
U 003	0087084	IC DTL LINE RECEIVER QUAD		MC1489L
U 004	0087085	RESISTOR NETWORK 7 3.9K OHM 2% 8 SIP		764-1-R3.9K
U 005	0087088	RESISTOR NETWORK 7 39K OHM 2% 8 SIP		764-1-R39K
U 006	0087089	CAPACITR NTWK 7-.001MF 100V 20% CER 8SIP		460CH102X0PD
U 007	0080979	IC TTL BUFFER INVERT HEX OPEN-COL	01295	SN7406N
U 008	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
U 009	0087086	RESISTOR NETWORK 7 4.7K OHM 2% 8 SIP		764-1-R4.7K
U 010	0087090	IC TTL GATE AND 4-IN DUAL		SN74LS21N
U 011	0170265	IC COMM INTERFACE USART PROGRAMMABLE		IP8251A
U 012	0086790	IC TIMER PROGRAMMABLE INTERVAL		8253
U 013	0087087	RESISTOR NETWORK 7 10K OHM 2% 8 SIP		764-1-R10K
U 022	0086898	IC BUS TRANSCVR 8-BIT		SN74LS245N
U 023	0084282	IC TTL GATE AND 2-IN QUAD	01295	SN74LS08N
U 024	0087456	IC TTL MULTIPLIER RATE DECADE		SN74167N
U 025	0087086	RESISTOR NETWORK 7 4.7K OHM 2% 8 SIP		764-1-R4.7K

OPTIONAL PRINTER ASSEMBLY - 221020

MODEL 4650

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
W 1	0221005	CABLE ASSY LOCAL PRINTER MDL 4652-3		

OPTIONAL PRINTER - I/O INTERFACE ASSEMBLY - 221002

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 001	0171551	CAPACITOR 3800 MF 20V		3050 GP 382U 020 JM
C 002	0171551	CAPACITOR 3800 MF 20V		3050 GP 382U 020 JM
C 003	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 004	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
J 001	0170202	CONN ASSY 16 PIN SINGLE ROW FEM PC MT		85928-5
J 002	0170201	CONN ASSY 11 PIN SINGLE ROW FEM PC MT		85928-3
J 003	0170200	CONN HEADER SGL ROW STRAIGHT 12-PIN PC		1-87220-2
J 004	0170204	CONN RECT 50-COND FEMALE RT ANGL MT		552725-1
L 001	0081740	INDUCTOR 250 UH FILTER CHOKE 1.3A	04213	6310-9
Q 001	0077147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
Q 002	0077147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
R 001	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 002	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 003	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 004	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
S 001	0170262	SWITCH MICRO SPDT PC MT 1.765 INCH LEVER		311SM703-H58

OPTIONAL PRINTER - FLEXCABLE ASSEMBLY - 220999

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
J 001	0170210	CONN FLAT CABLE 12 PIN FEM		65801-012
S 001	0220990	SWITCH ASSY PRINTER CONTROL MDL 4652-3		

DCV/ALARM REAR PANEL INTERFACE CABLE ASSEMBLY - 257137

REF DESIG		PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
	1	0085130	CABLE FLAT 10-COND. 28 AWG	76381	3365/10
	2	0257136	PLATE, CONNECTOR ADAPTER MDL 4657		
	3	0074046	CONN RECT SLIDING LOCK POST	71468	
	4	0085339	ADHESIVE & SEALANT MED STR WICKS IN 50CC	05972	290-31
P	1	0085048	CONN FLAT CABLE 10 PIN FEM W/STRN RELIEF	00779	86981-2
P	2	0089405	CONN FLAT CABLE 9 PIN D-SUBMIN MALE		

DCV/ALARM MONITOR CABLE ASSEMBLY - 252859

REF DESIG		PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
	1	0078027	CABLE 2-26AWG COND FOIL SHIELD-GND WIRE		PER SA STD #13-1005
		3173623	CONN RECT PLASTIC SHELL STRAIGHT SIZE E		DE 51218-1
		3173622	CONN RECT SLIDING LOCK RETAINER SIZE E		DE 51224-1
	4	0077938	TUBING HEAT SHRINK .375ID SHRINKS TO.187	92194	FIT-221-3/8 BLACK
J	1	3078944	CONN RECT 9-COND FEMALE W/FLANGE	71468	

FSCM - MANUFACTURERS CROSS REFERENCE

FSCM	Manufacturer	City	State
00779	Amp, Inc.	Harrisburg	PA
01121	Allen-Bradley Co.	Milwaukee	Wisc
01295	Texas Instruments, Inc.	Dallas	Texas
04713	Motorola Semiconductor Pdts	Phoenix	Ariz
050397	Kemet Div-Union Carbide	Cleveland	Ohio
12040	National Semiconductor Corp.	Danbury	Conn
13715	Fairchild Semiconductor Corp.	San Rafael	Calif
14655	Cornell-Dubilier Elec. Corp.	S. Plainfield	NJ
15801	Fenwal Electronics	Framingham	Mass
18324	Signetics Corp.	Sunnyvale	Calif
24681	Memcor, Inc., Components Div /Tru-Ohm/	Huntington	Ind
28480	Hewlett-Packard	Palo Alto	Calif
31718	Fairchild Microwave Products	Mountain View	Calif
53021	Sangamo Electric Co.	Springfield	Ill
70903	Belden Manufacturing Co.	Chicago	Ill
71279	Cambridge Thermionic Corp.	Cambridge	Mass
71590	Centralab	Milwaukee	Wisc
72259	Nytronics, Inc.	Berkley Hts.	NJ
72982	Erie Resistor Corp.	Erie	PA
73138	Helipot-Div. Beckman Instr.	Fullerton	Calif
74970	Johnson, E.F. Co.	Waseca	Minn
75915	Littlefuse, Inc.	Des Plaines	Ill
78488	Stackpole Carbon Co.-Magnet Div.	St. Marys	Penn
79089	Radio Corp. of America	Harrison	NJ
80183	Sprague Pdts Co.	N. Adams	Mass
80368	Sylvania Electric Pdts, Inc.	New York	NY
82877	Rotron Mfg. Co.	Woodstock	NY
91637	Dale Products, Inc.	Columbus	Neb
98291	Sealectro Corp.	Mamasoneck	NY

CHAPTER 7
DIAGRAMS

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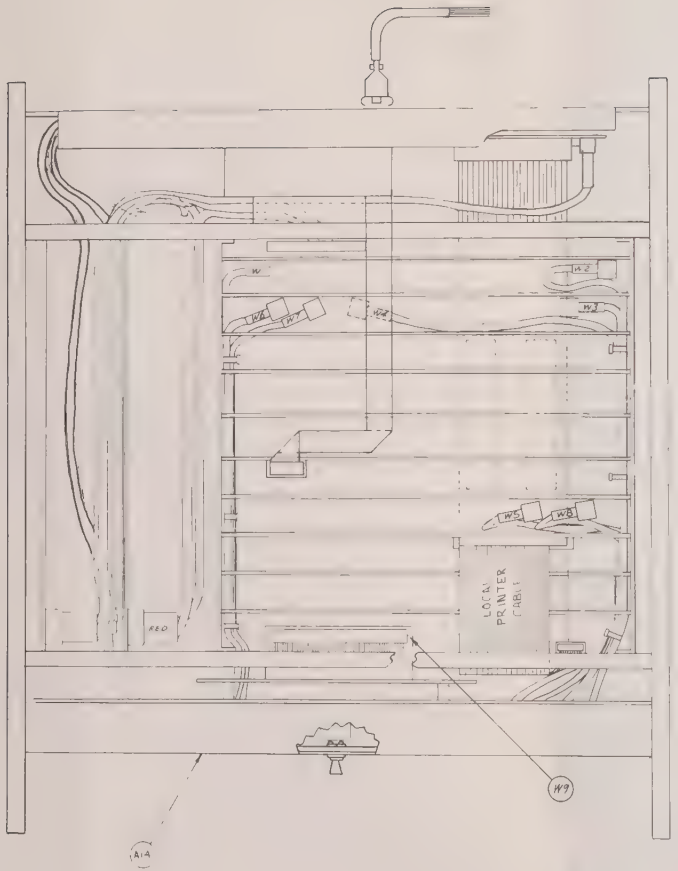
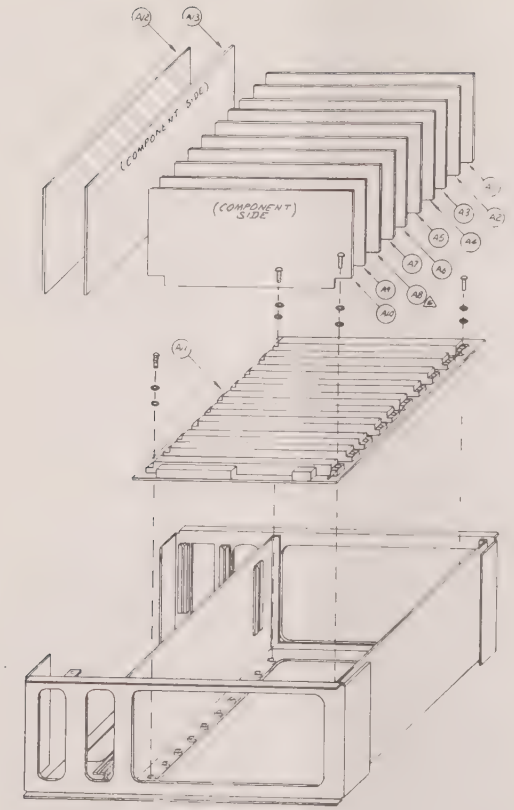


NOTES.

1 W1 THRU W9 USED FOR REFERANCE ONLY

Figure 7.1. Chassis Assembly, Cable Installation Reference (Sheet 1 of 3)



NOTE:
△8 OPTIONAL IEEE-488 OR RS-232.

Figure 7.1. Chassis Assembly, Printed Circuit Board Installation Reference (Sheet 2 of 3)

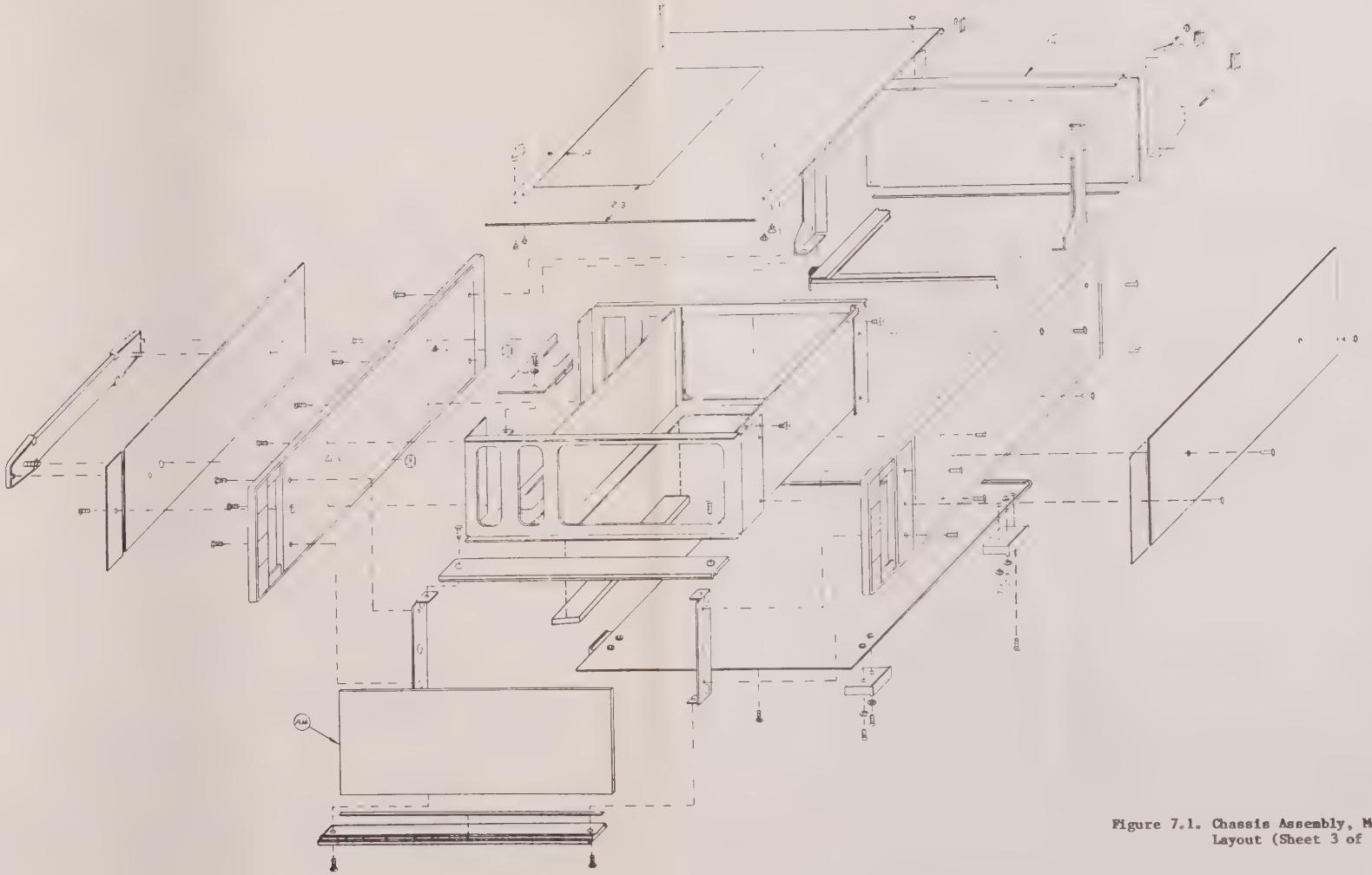


Figure 7.1. Chassis Assembly, Mechanical Layout (Sheet 3 of 3)

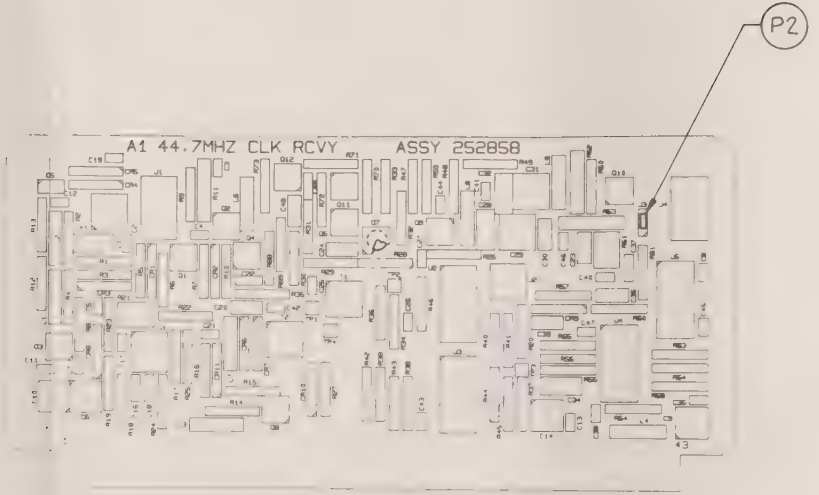
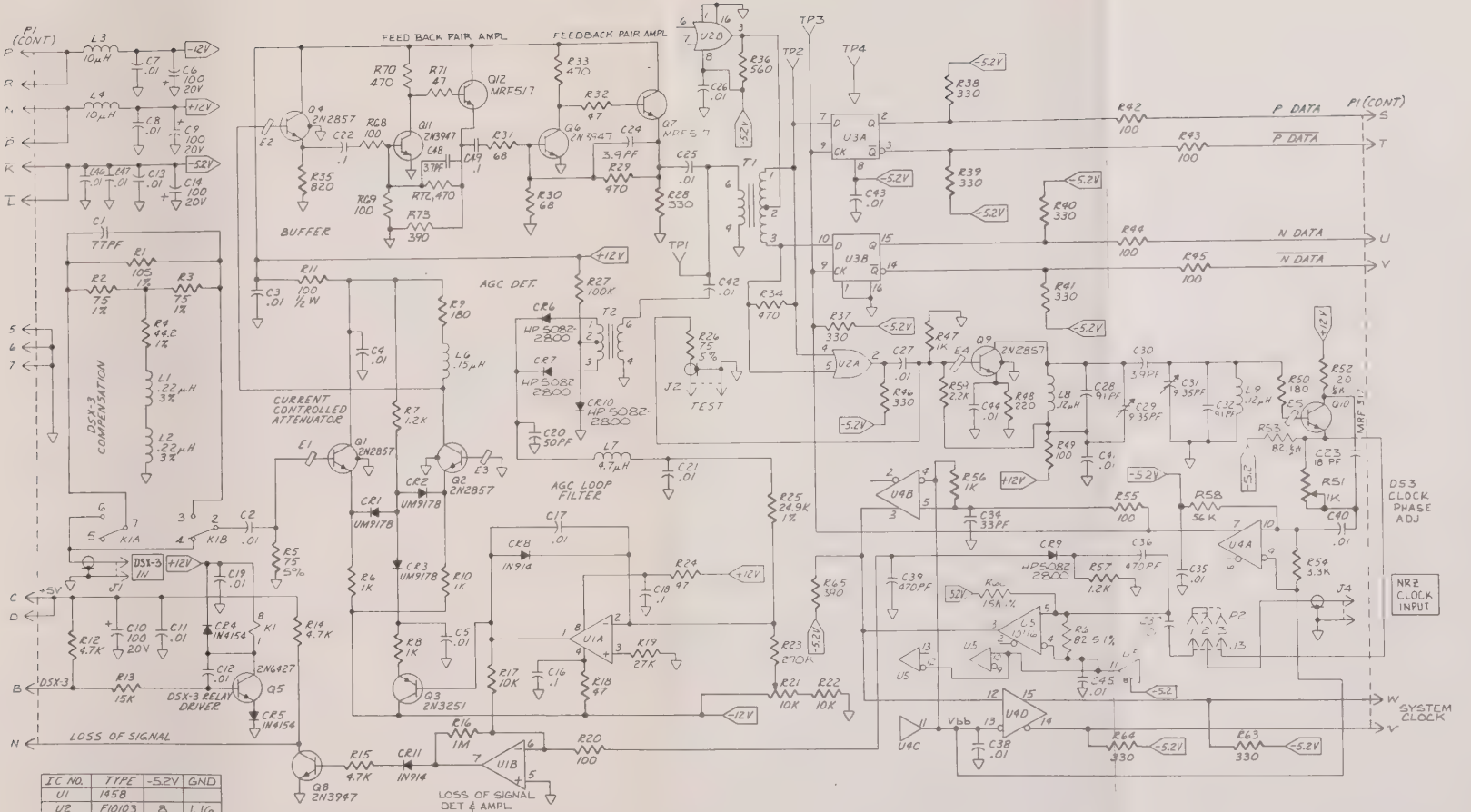


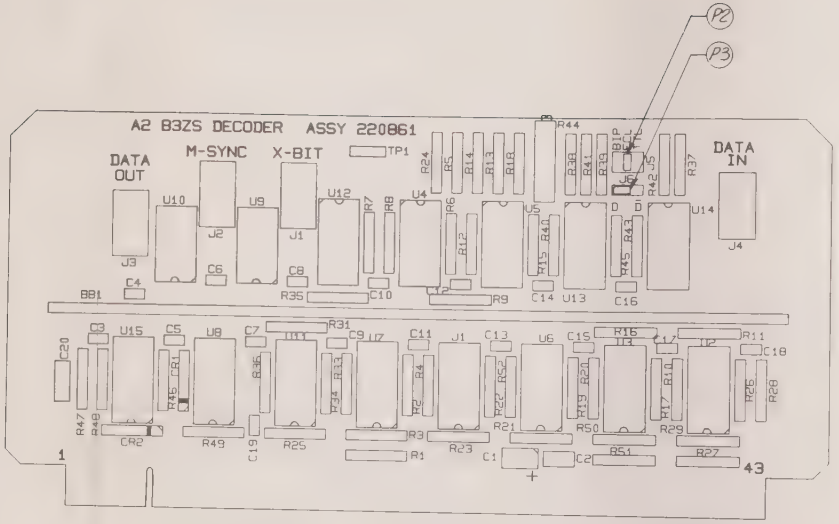
Figure 7.2. 44.7 MHz Clock Recovery Assembly (A1), Component Location



IC NO.	TYPE	-5.2V	GND
U1	1458		
U2	F10103	8	1,16
U3	F10131	8	1,16
U4, U5	F10116	8	1,16

NOTES:
1. C28 & C32 CAN BE FACTORY SELECT, IF REQUIRED FOR ALIGNMENT.
2. C15, C33, L5 & R62 NOT ASSIGNED.

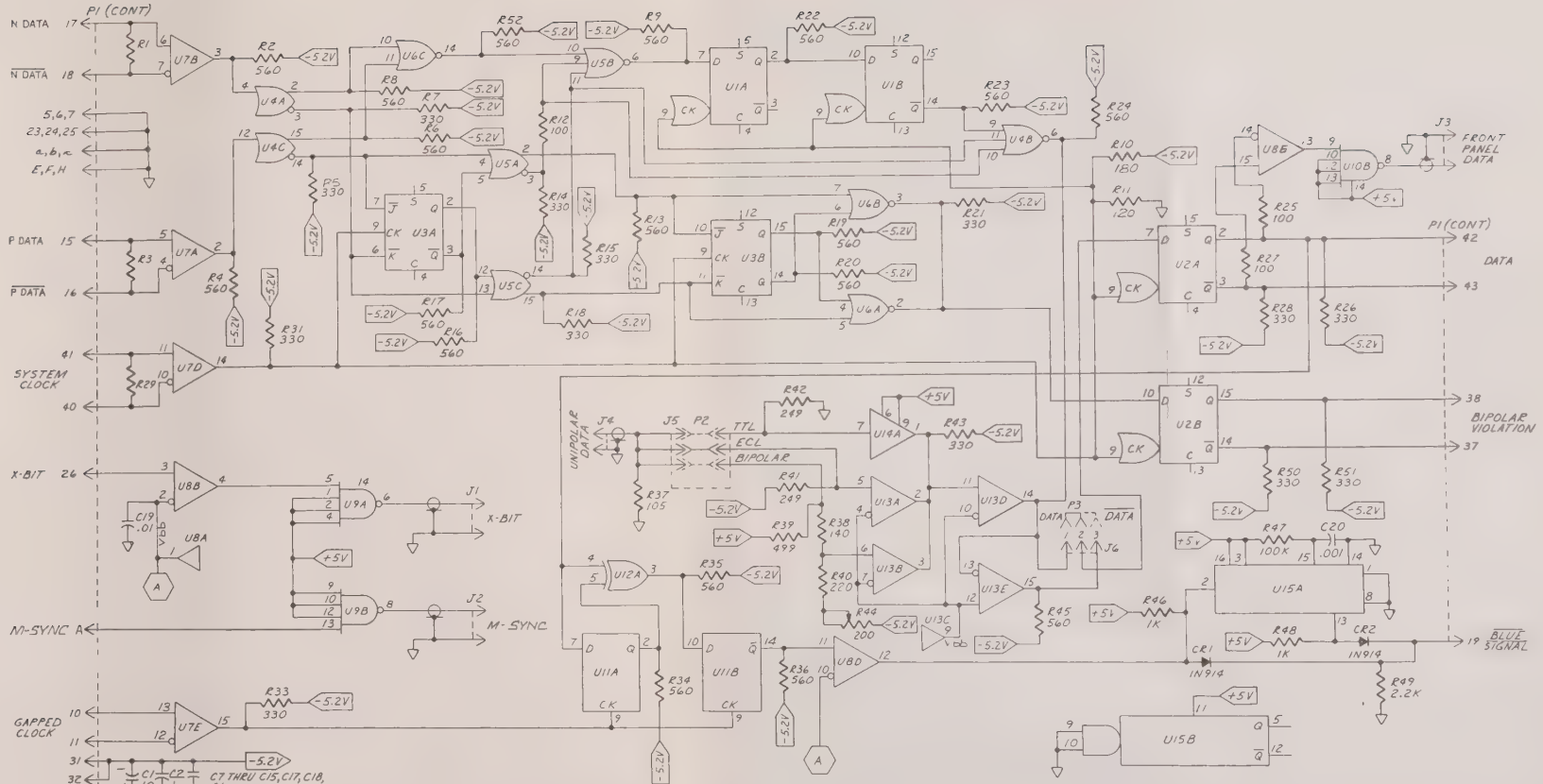
Figure 7.3. 44.7 MHz Clock Recovery Assembly (A1), Schematic



NOTES:

REFERENCE DESIGNATIONS NOT USED: R30 AND R32.

Figure 7.4. B3ZS Decoder Assembly (A2), Component Location



NOTES:

THE FOLLOWING REFERENCE DESIGNATION ARE NOT USED: R30 & R32.

IC NO.	TYPE	GND	-5.2	+5
U1	F10131	1,16	8	
U2	F10131	1,16	8	
U3	F10135	1,16	8	
U4	F10105	1,16	8	
U5	F10105	1,16	8	
U6	F10102	1,16	8	
U7	F10115	1,16	8	
U8	F10125	1,16	8	9
U9	SN74S140	7		14
U10	SN74S140	7		14

IC NO.	TYPE	GND	-5.2	+5
U11	F10131	1,16	8	
U12	F10107	1,16	8	
U13	F10115	1,16	8	
U14	F10124	9,16	8	
U15	SN54LS123	1,8,9,10		3,11,16
		14		

Figure 7.5. B3ZS Decoder Assembly (A2), Schematic

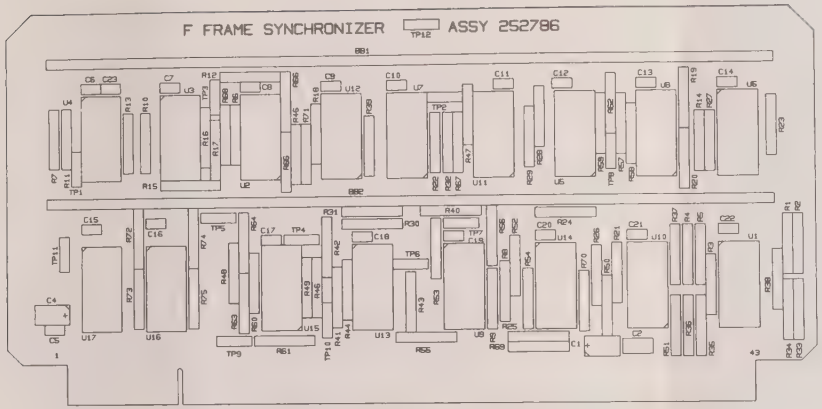
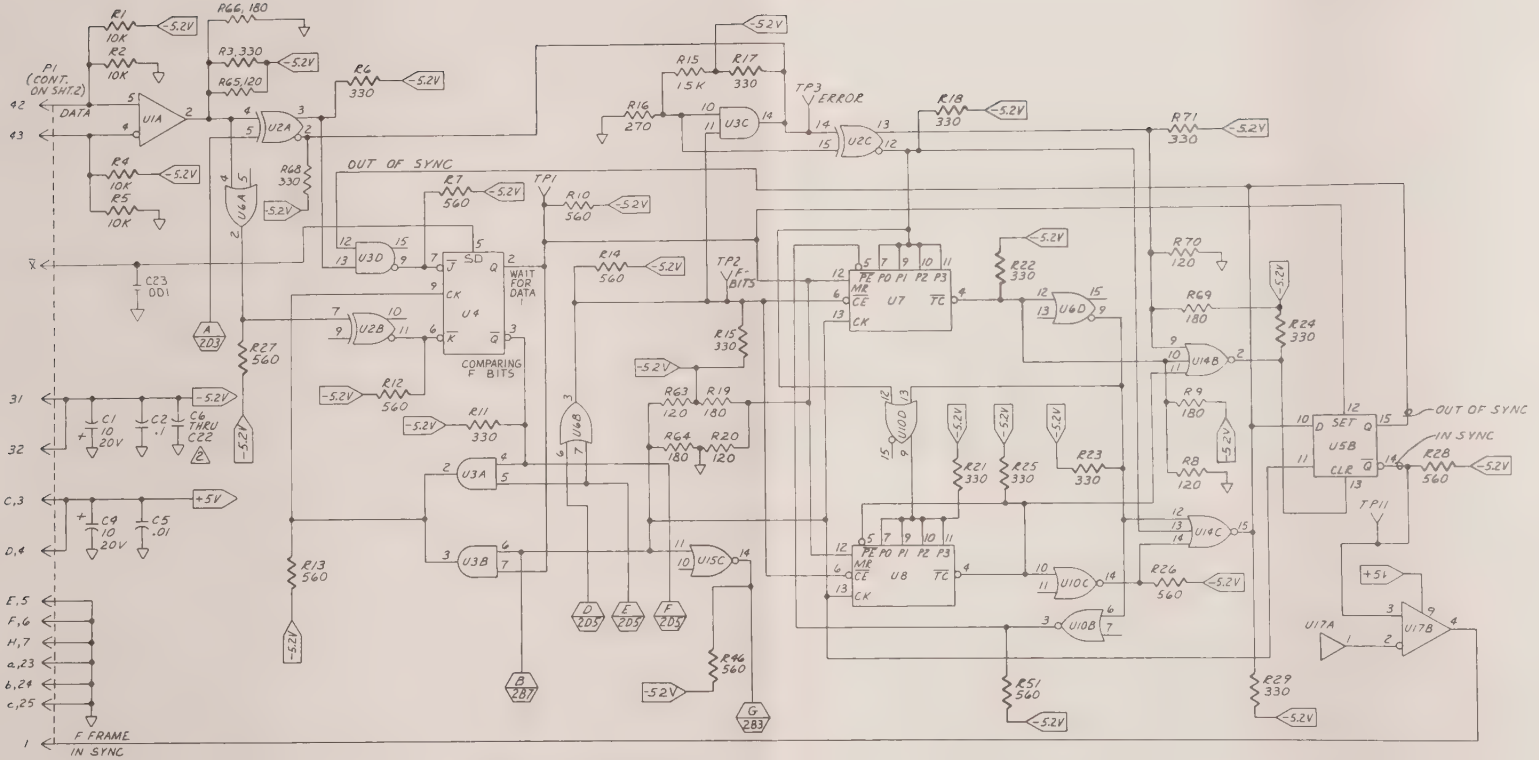


Figure 7.6. F-Frame Synchronizer Assembly (A3), Component Location



IC NO.	TYPE	GND	-5.2V	+5V
U1	F10115	1,16	8	
U2	F10107	1,16	8	
U3	F10104	1,16	8	
U4	F10135	1,16	8	
U5	F10131	1,16	8	
U6	F10103	1,16	8	
U7	F10016	1,16	8	
U8	F10016	1,16	8	
U9	F10104	1,16	8	
U10	F10102	1,16	8	
U11	F10016	1,16	8	
U12	F10016	1,16	8	
U13	F10016	1,16	8	
U14	F10106	1,16	8	
U15	F10102	1,16	8	
U16	F10105	1,16	8	
U17	F10125	16	8	9

NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE 1/8 W, 5%

2. C6 THRU C22 ARE ALL .01μF

Figure 7.7. F-Frame Synchronizer Assembly (A3), Schematic (Sheet 1 of 2)

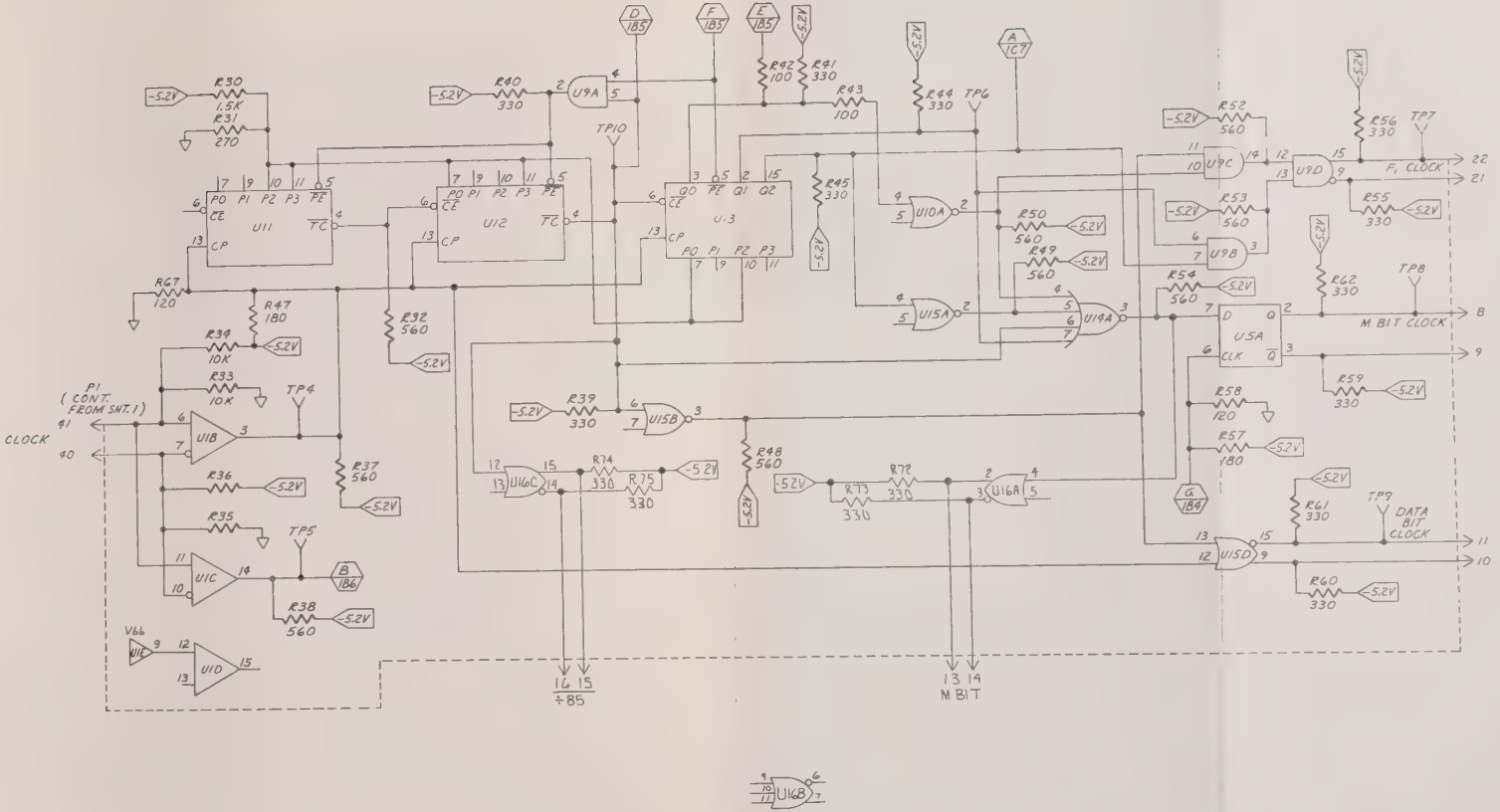


Figure 7.7. P-Frame Synchronizer Assembly (A3), Schematic (Sheet 2 of 2)

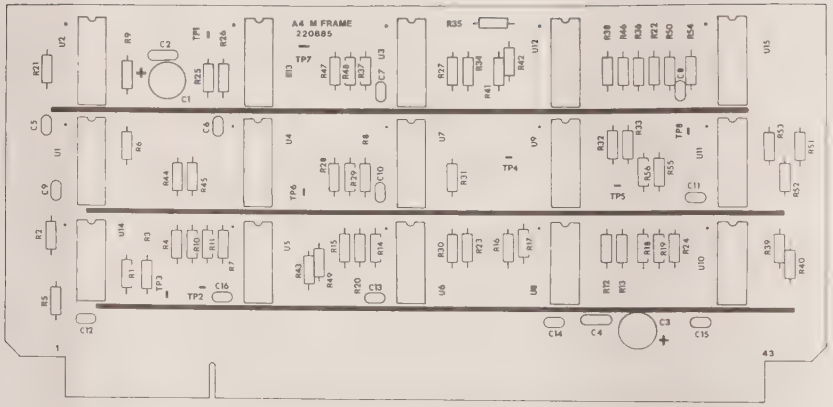
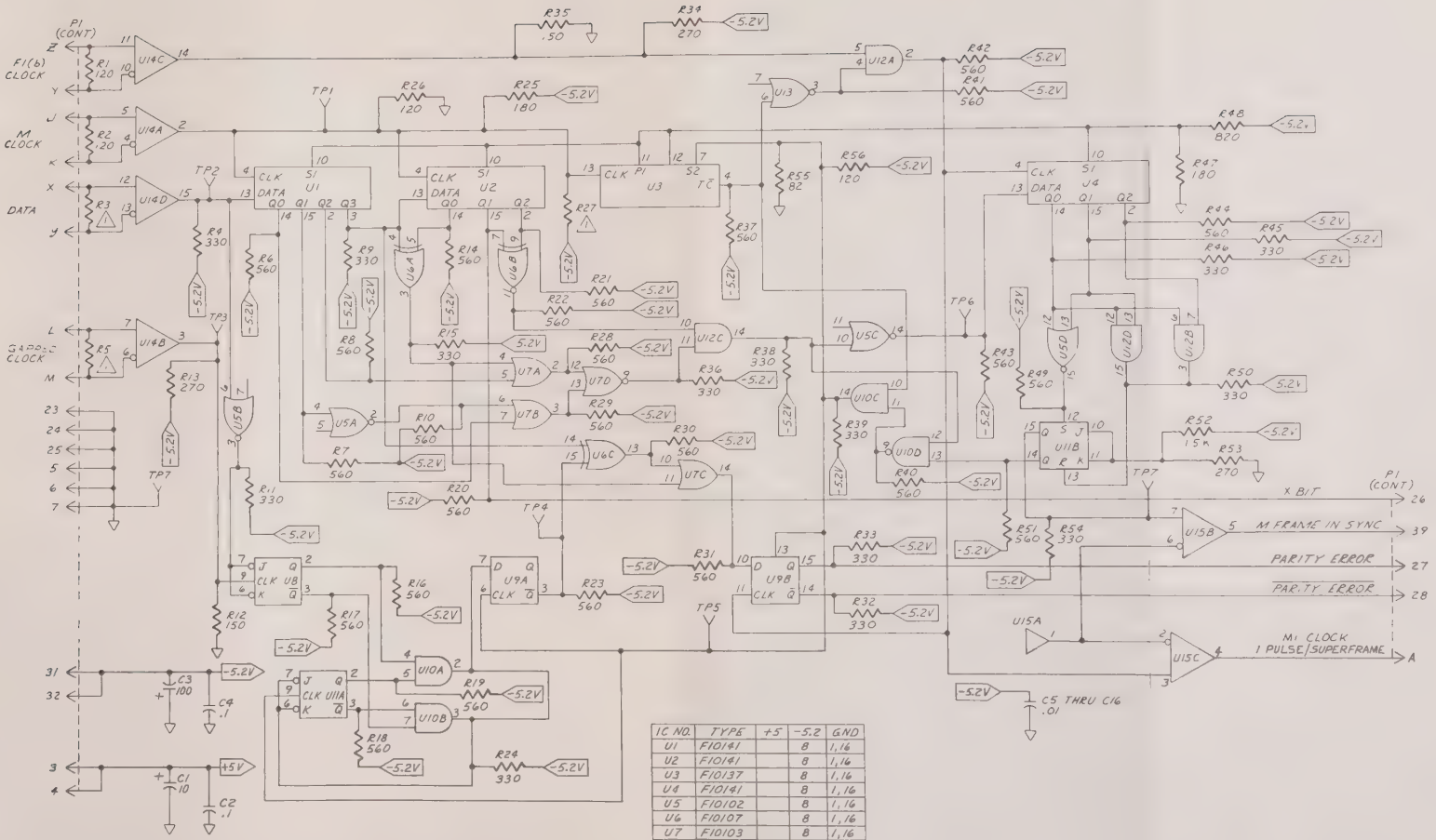


Figure 7.8. M-Frame Synchronizer Assembly (A4), Component Location



IC NO.	TYPE	+5	-5.2	GND
U1	F10141		8	1,16
U2	F10141		8	1,16
U3	F10137		8	1,16
U4	F10141		8	1,16
U5	F10102		8	1,16
U6	F10107		8	1,16
U7	F10103		8	1,16
U8	F10135		8	1,16
U9	F10131		8	1,16
U10	F10104		8	1,16
U11	F10135		8	1,16
U12	F10104		8	1,16
U13	F10102		8	1,16
U14	F10115		8	1,16
U15	F10125	9	8	16

Figure 7.9. M-Frame Synchronizer Assembly (A4), Schematic

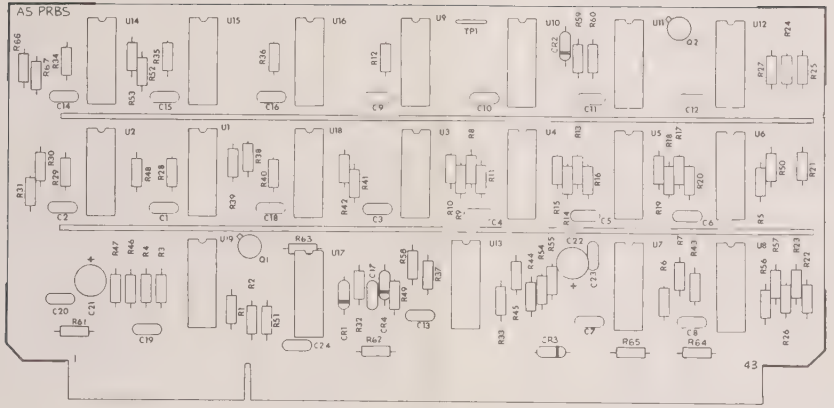
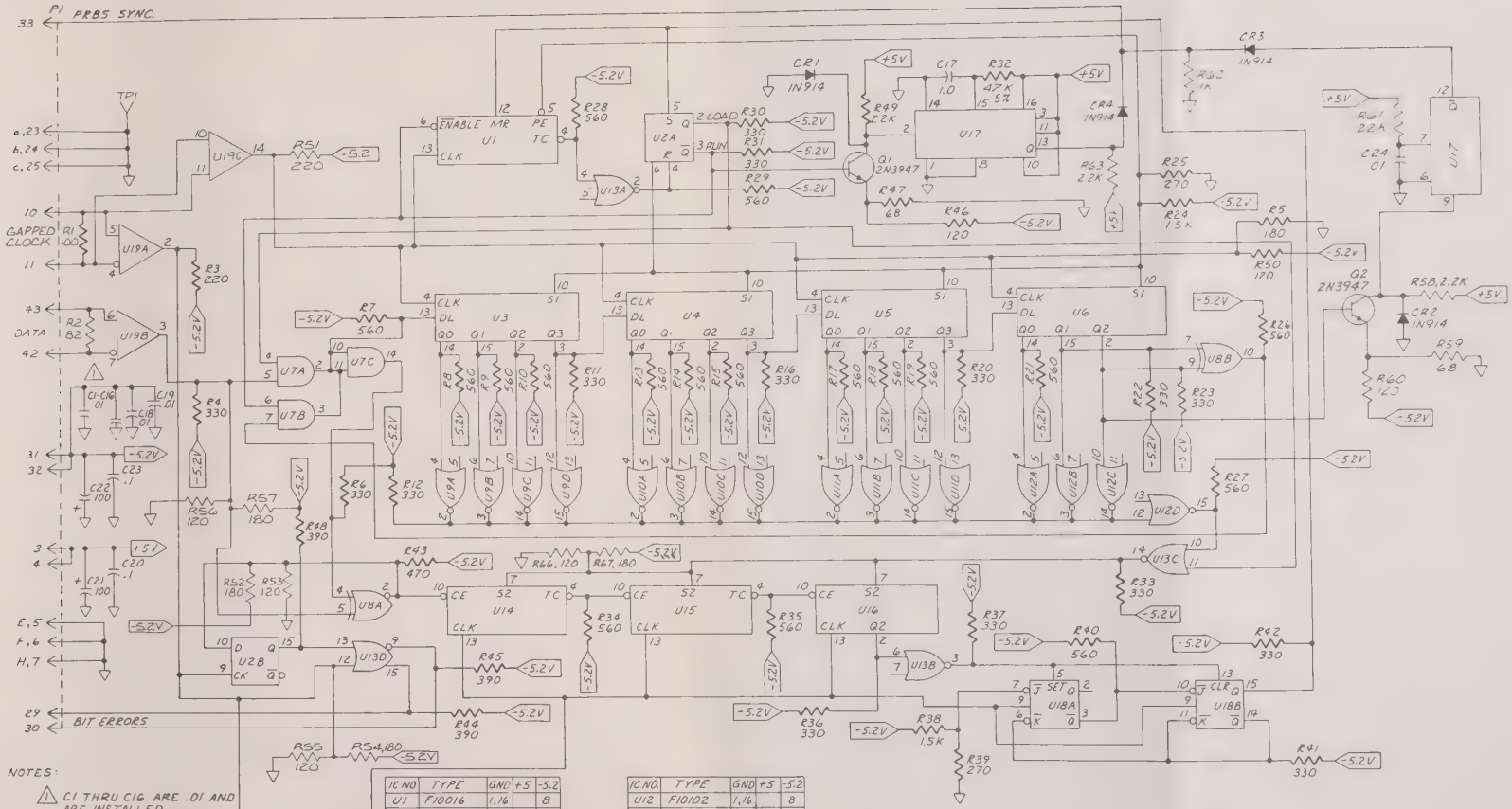


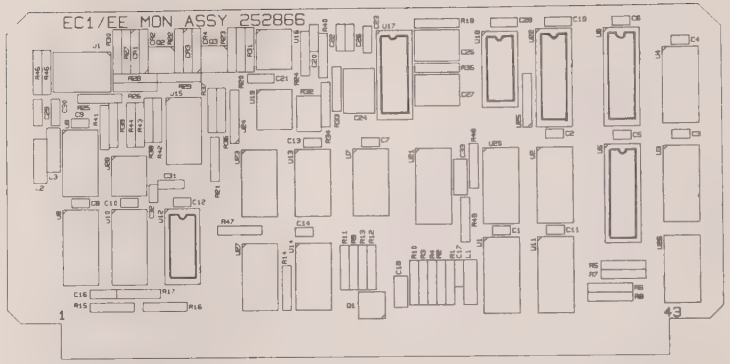
Figure 7.10. Pseudo Random Bit Sequence Generator Assembly (A5), Component Location



IC NO	TYPE	GND	+5	-5.2
U1	F10016	1,16		8
U2	F10131	1,16		8
U3	F10141	1,16		8
U4	F10141	1,16		8
U5	F10141	1,16		8
U6	F10141	1,16		8
U7	F10104	1,16		8
U8	F10107	1,16		8
U9	F10102	1,16		8
U10	F10102	1,16		8
U11	F10102	1,16		8

IC NO.	TYPE	GND	+5	-5.2
U12	F10102	1,16		8
U13	F10102	1,16		8
U14	F10136	1,16		8
U15	F10136	1,16		8
U16	F10136	1,16		8
U17	LS123	8	16	
U18	F10135	1,16		8
U19	F10115	1,16		8

Figure 7.11. Pseudo Random Bit Sequence Generator Assembly (A5), Schematic

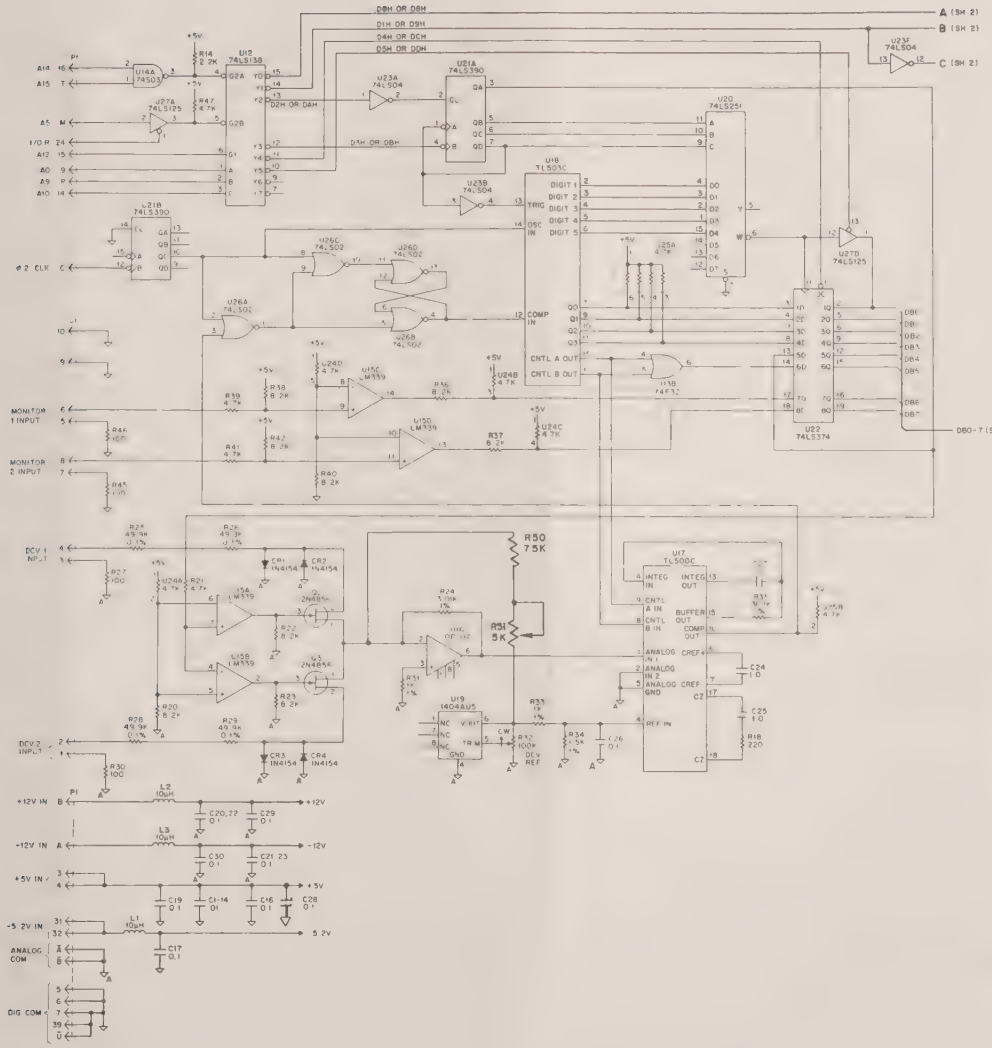


NOTES:

1. REF DES NOT USED: C15, R19

Figure 7.12. Error Counter 1/External Event Monitor Assembly (A6), Component Location

252866A
35R049A



REFERENCE DESIGNATION	TYPE NUMBER	PIN NUMBER			
		+5V	+12V	-12V	GND
26	74LS02	14	-	-	7
U14	74LS03	14	-	-	7
U23	74LS04	14	-	-	7
U13	74F32	14	-	-	7
U7	74S74	14	-	-	7
U27	74LS125	14	-	-	-
U12	74LS138	16	-	-	8
U9	74S196	14	-	-	7
U20	74LS251	16	-	-	8
U5,6	74S374	20	-	-	10
U22	74LS374	20	-	-	10
U10,11,21	74LS390	16	-	-	8
U2,3,4	93S16	16	-	-	8
8	93S10	16	-	-	8
28	555	8	-	-	1
7	10125	9	-	-	16
U15	LM339	3	-	12	-
U16	OP-07	-	7	4	-
U19	1405AU5	-	2	-	-
U17	TL500C	-	16	12	11
U18	TL503C	16	-	-	8

Figure 7.13. Error Counter 1/External Event Monitor Assembly (A6), Schematic (Sheet 1 of 2)

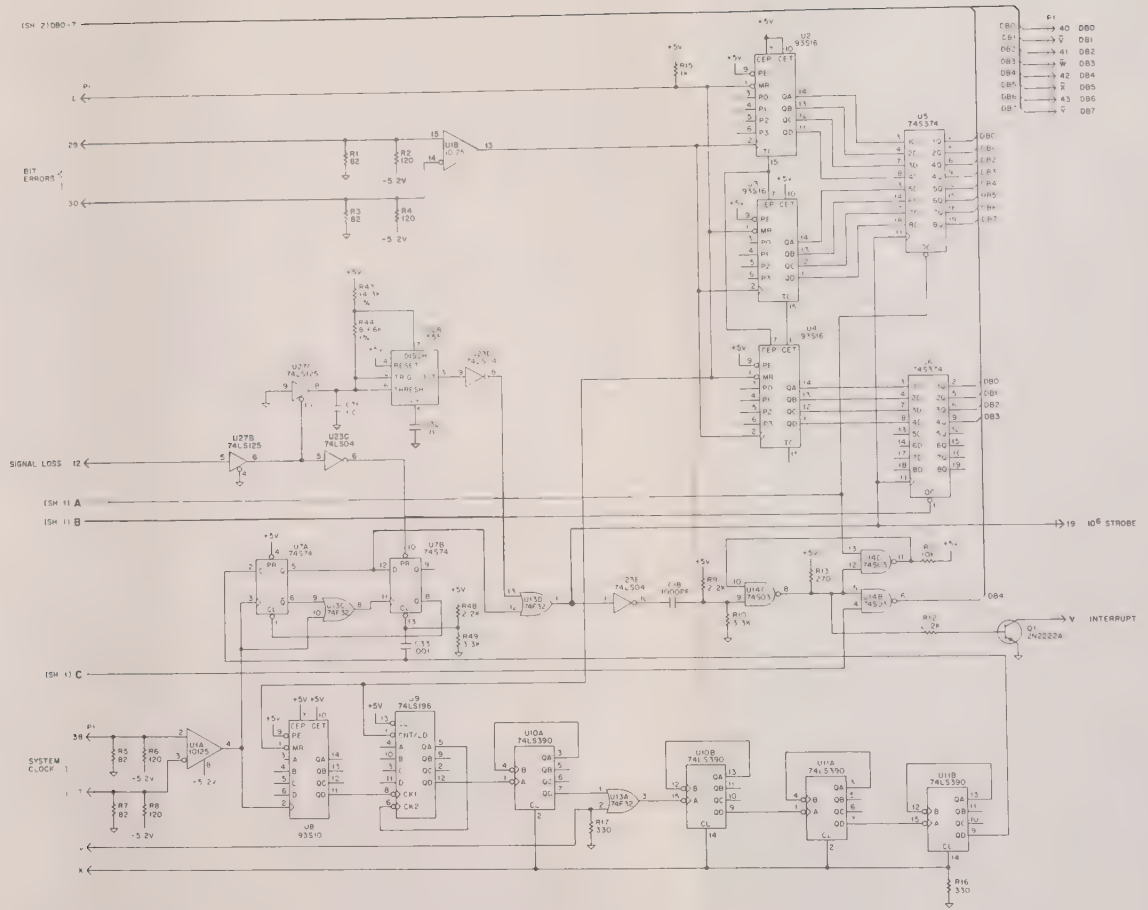


Figure 7.13. Error Counter 1/External Event Monitor Assembly (A6), Schematic (Sheet 2 of 2)

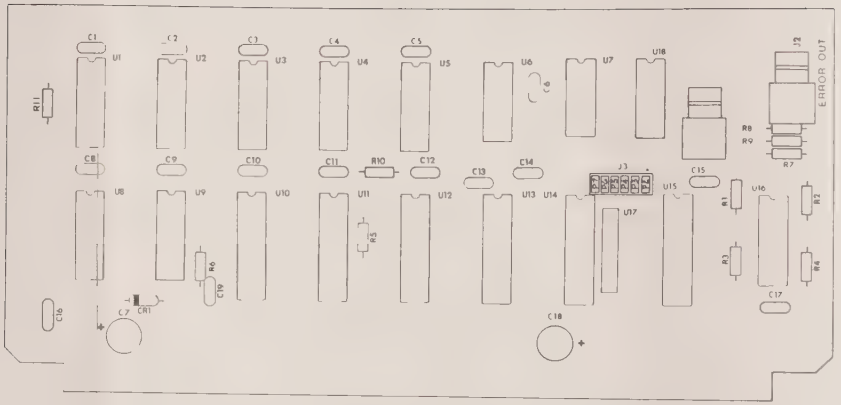


Figure 7.14. Error Counters 2 and 3 Assembly (A7), Component Location

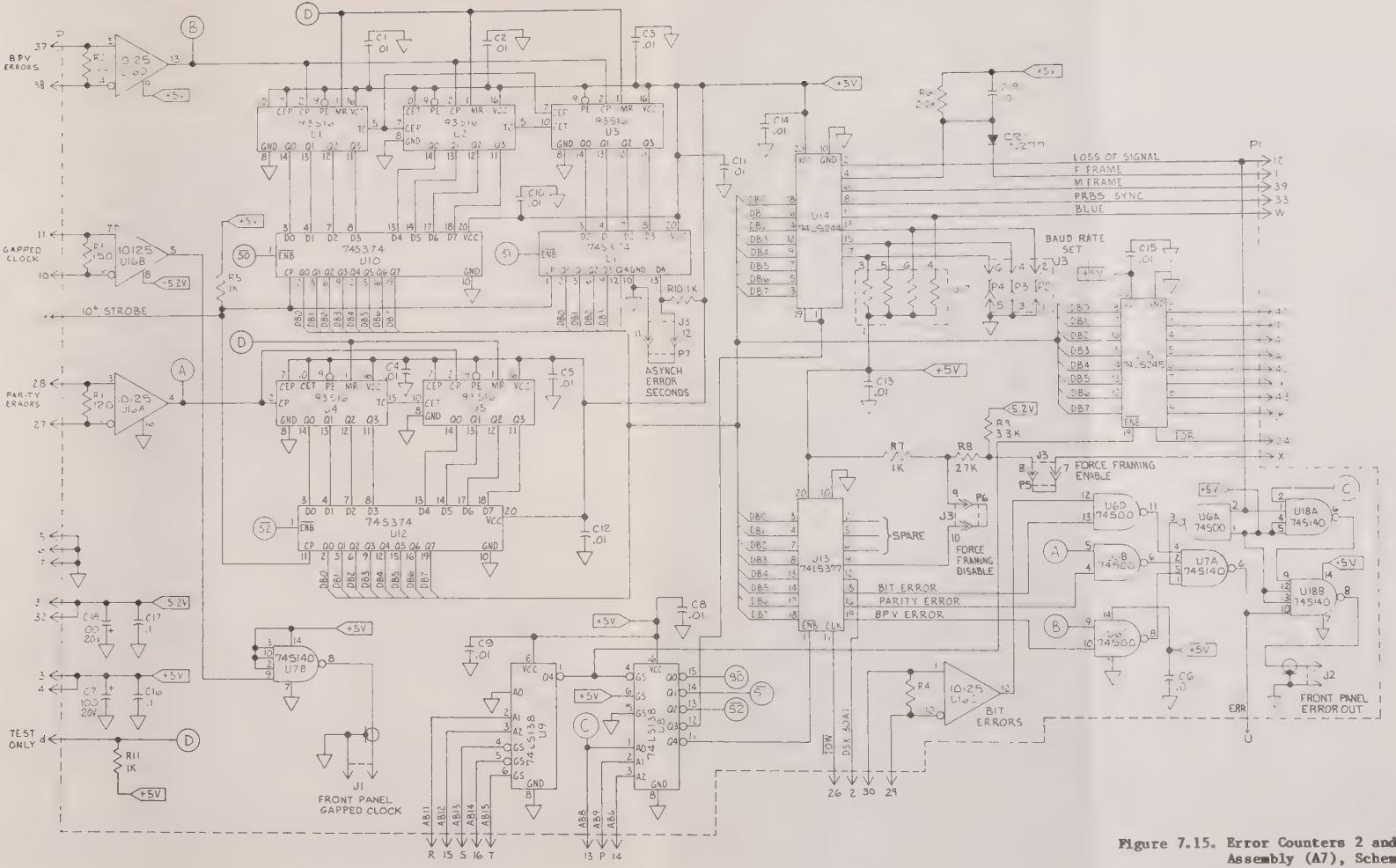
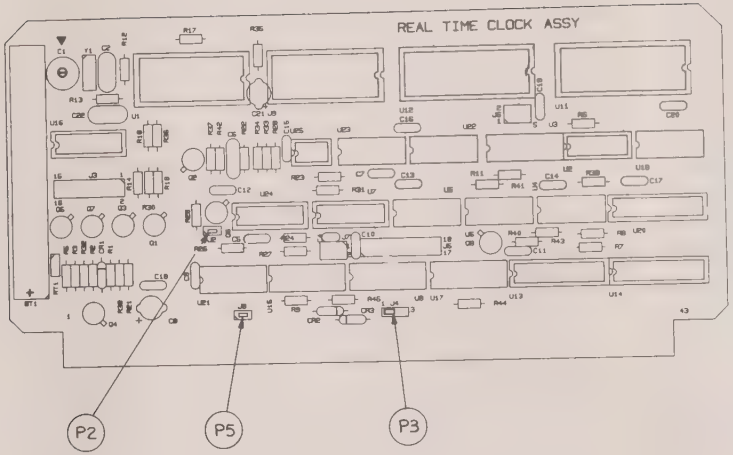


Figure 7.15. Error Counters 2 and 3 Assembly (A7), Schematic



NOTES:
1. REF DES NOT USED: C3, J1, R4, R10, R15, R16, R20, R25, U10, U19

Figure 7.16. Real-Time Clock Assembly (A9), Component Location

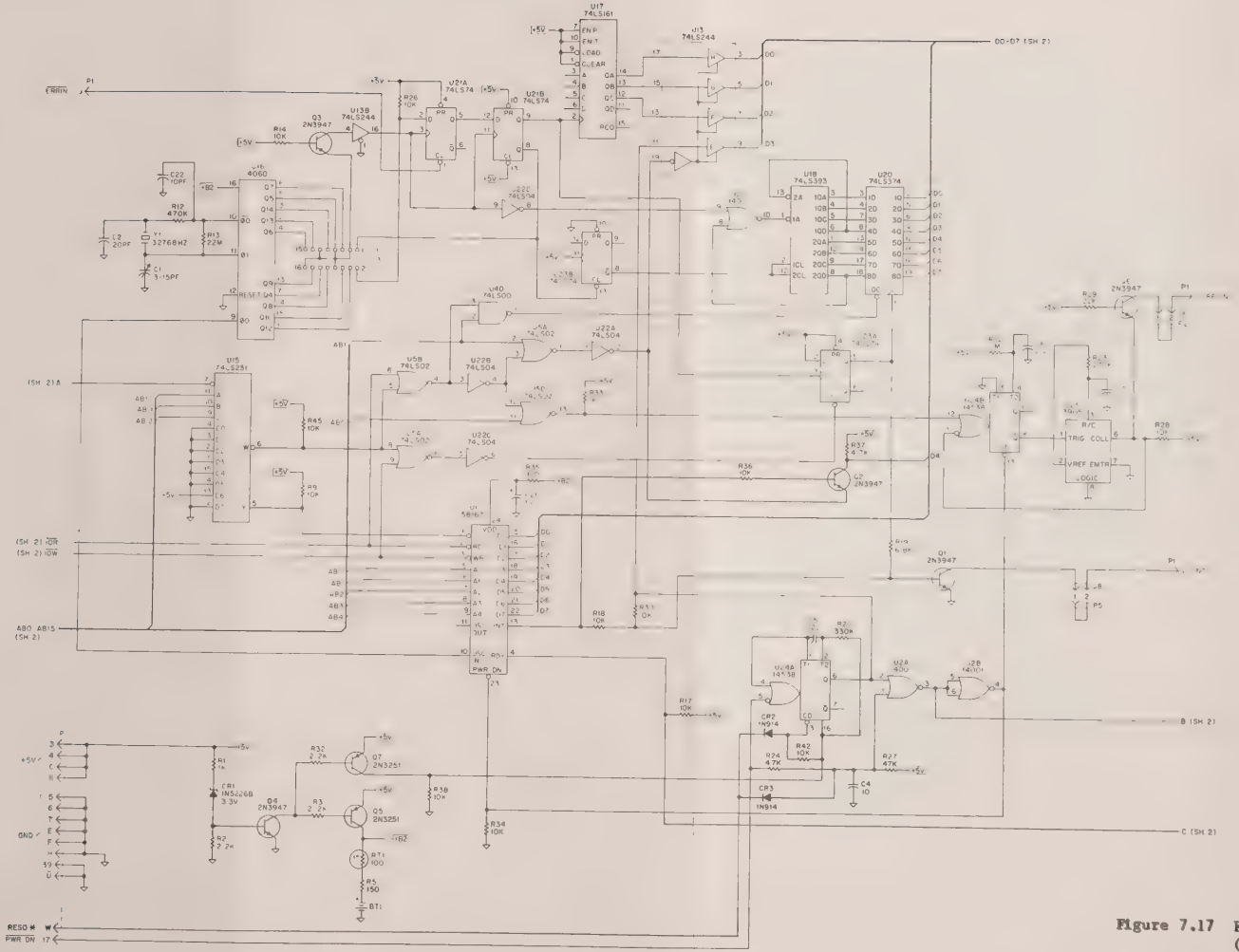
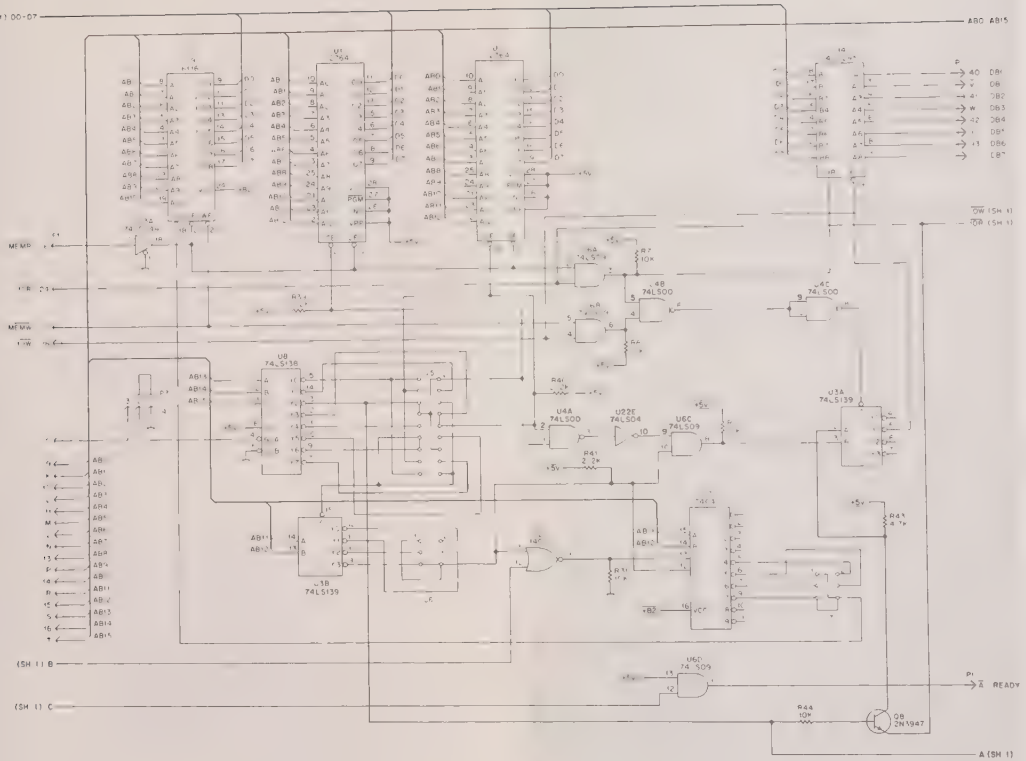


Figure 7.17 Real-Time Clock Assembly, (A9), Schematic (Sheet 1 of 2)

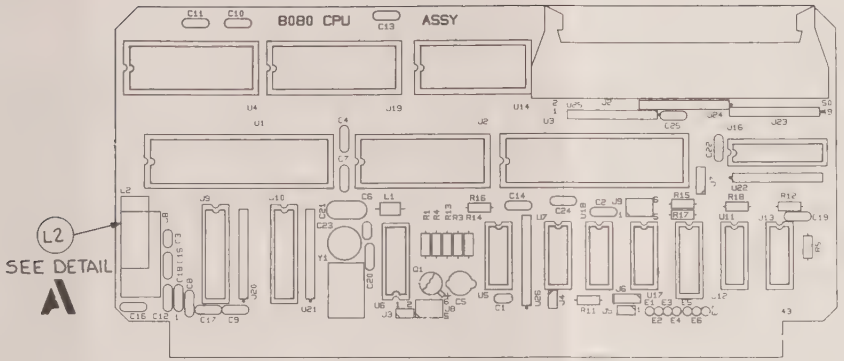
252875B

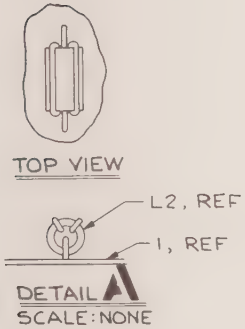
35R049A



IC	TYPE	+5V	GND
U1	5816?	-	12
U2	14001	14	7
U3	74LS139	16	8
U4	74LS00	14	7
U5	74LS02	14	7
U6	74LS09	14	7
U7	74C42	-	8
U8	74LS138	16	8
U9	6116	-	12
U11,12	2764	28	14
U13	74LS244	20	10
U14	74LS245	"	"
U15	74LS251	"	"
U16	4060	"	"
U17	74LS161	"	"
U18	74LS393	"	"
U20	74LS374	"	"
U21,23	74LS74	"	"
U22	74LS04	14	7
U24	14538	-	8
U25	3905	5	4

Figure 7.17 Real-Time Clock Assembly (A9), Schematic (Sheet 2 of 2)





NOTES:
1. REF DES NOT USED: J1, R2, R6-R10, U15

Figure 7.18. 8080 CPU Assembly (A10), Component Location

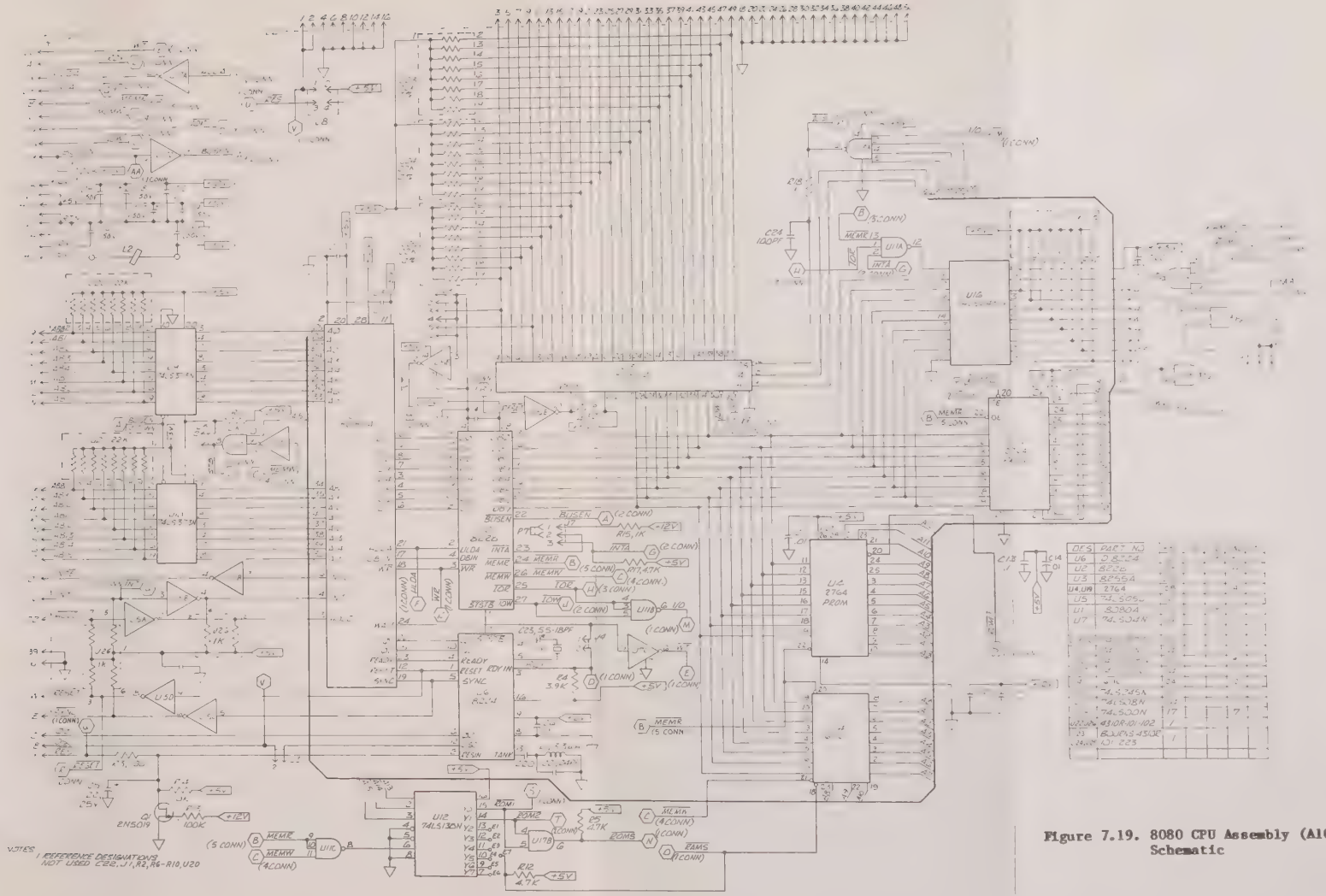
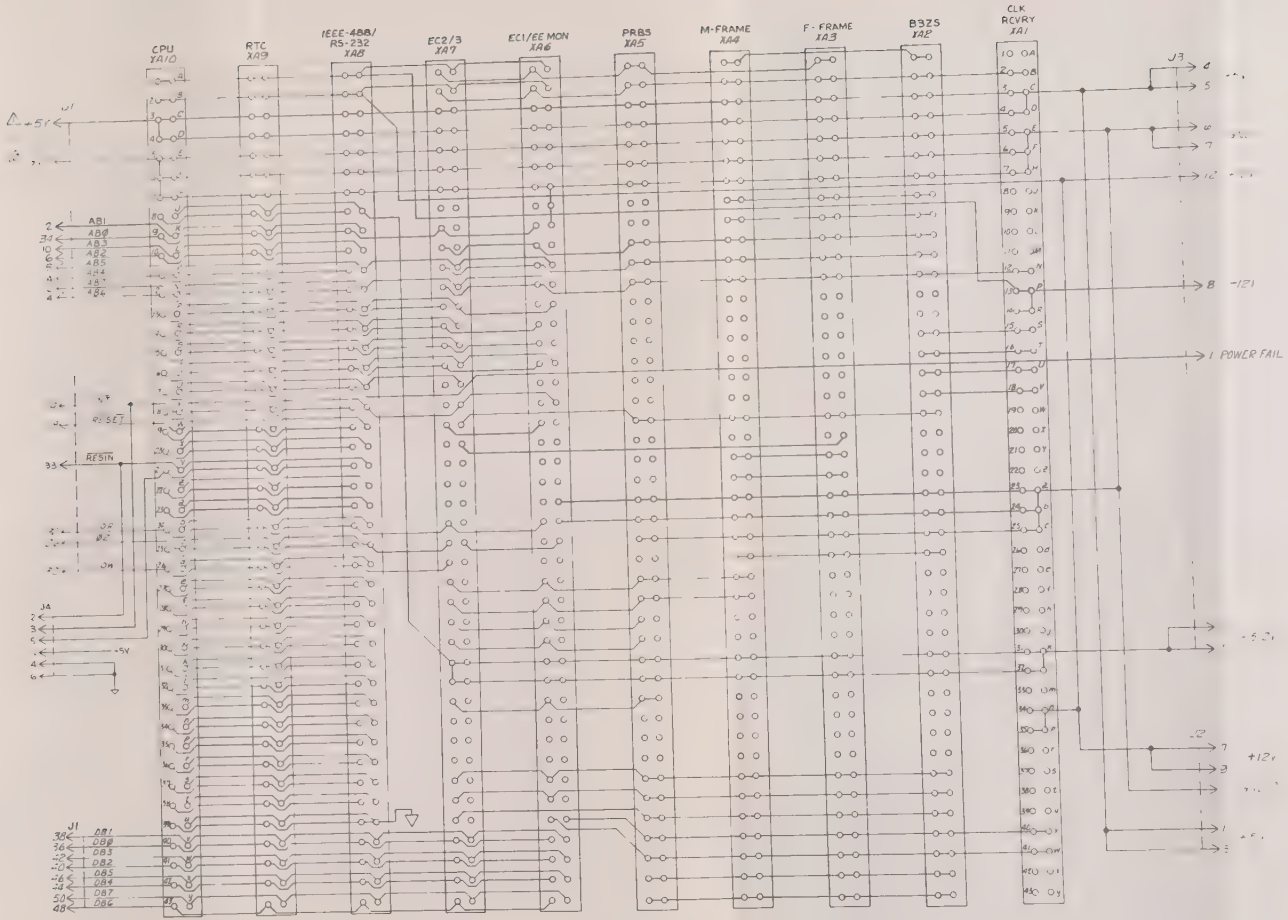


Figure 7.19. 8080 CPU Assembly (A10), Schematic

Figure 7.20. Motherboard Assembly (A11), Component Location



NOTES:
1. THE FOLLOWING PINS ARE ALL COMMON FOR +5V : 17 THRU 23, 25, 27, 29, 31.
2. THE FOLLOWING PINS ARE ALL COMMON FOR GND : 1, 3, 5, 7, 9, 11, 13, 15, 16, 35, 37, 39, 41, 43, 45, 47 AND 49.
3. THE FOLLOWING PINS ARE ALL COMMON FOR GND : 2, 4, 6, 8 AND 10.

Figure 7.21. Motherboard Assembly (A11), Schematic

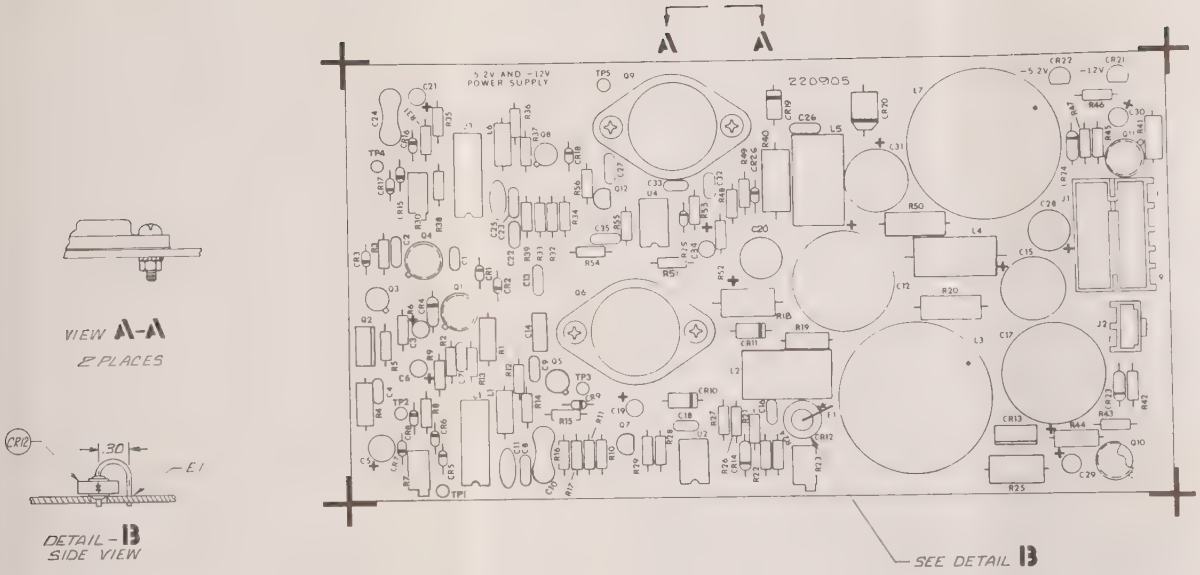


Figure 7.22. -5.2V/-12V Power Supply Assembly (A12), Component Location

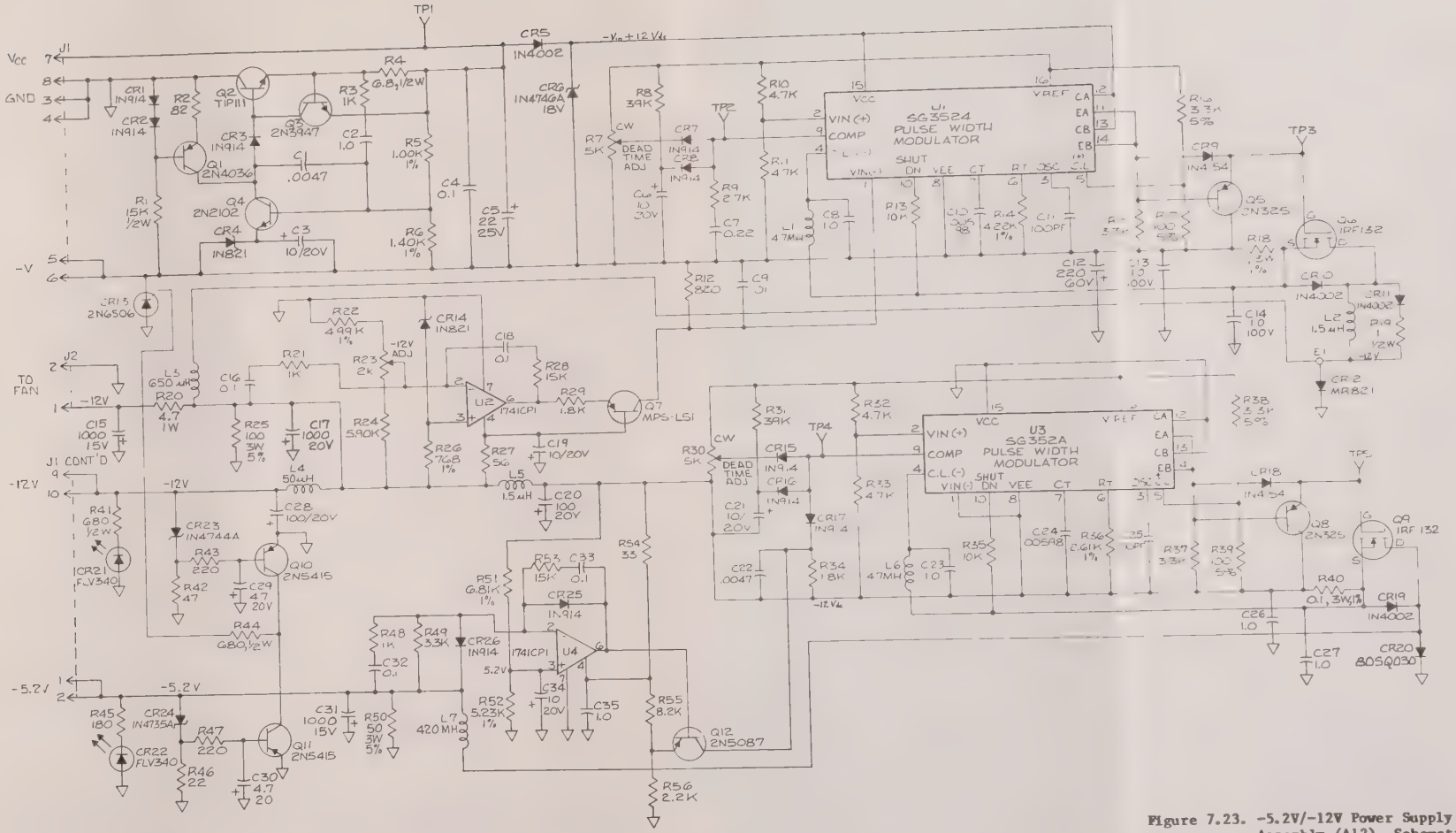
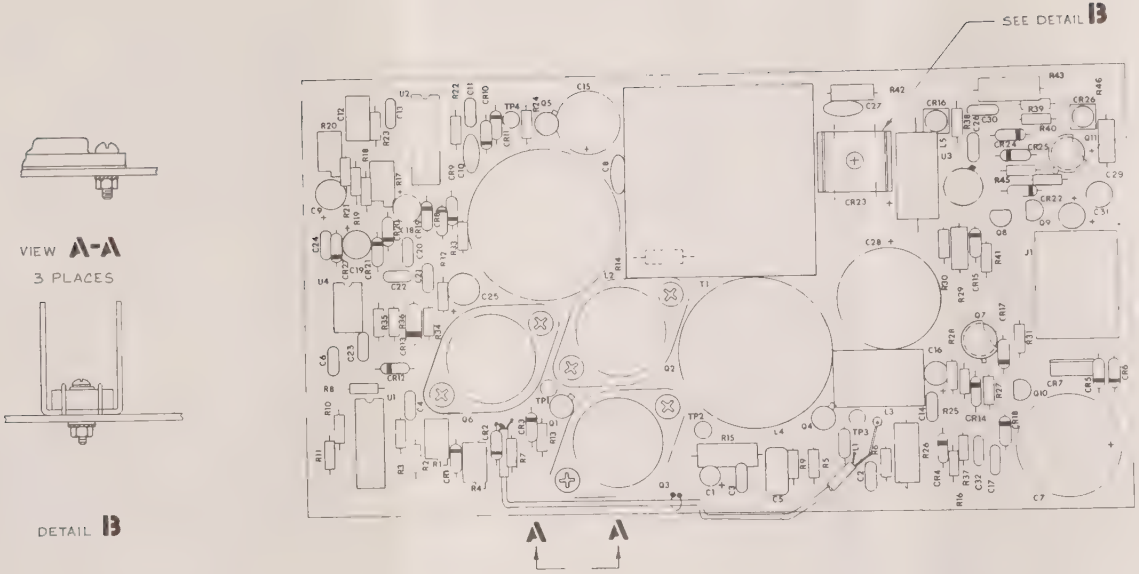


Figure 7.23. -5.2V/-12V Power Supply Assembly (A12), Schematic



NOTES:

1. REF DESIGNATIONS NOT USED: R12

Figure 7.24. +5.0V/+12.0V Power Supply Assembly (A13), Component Location

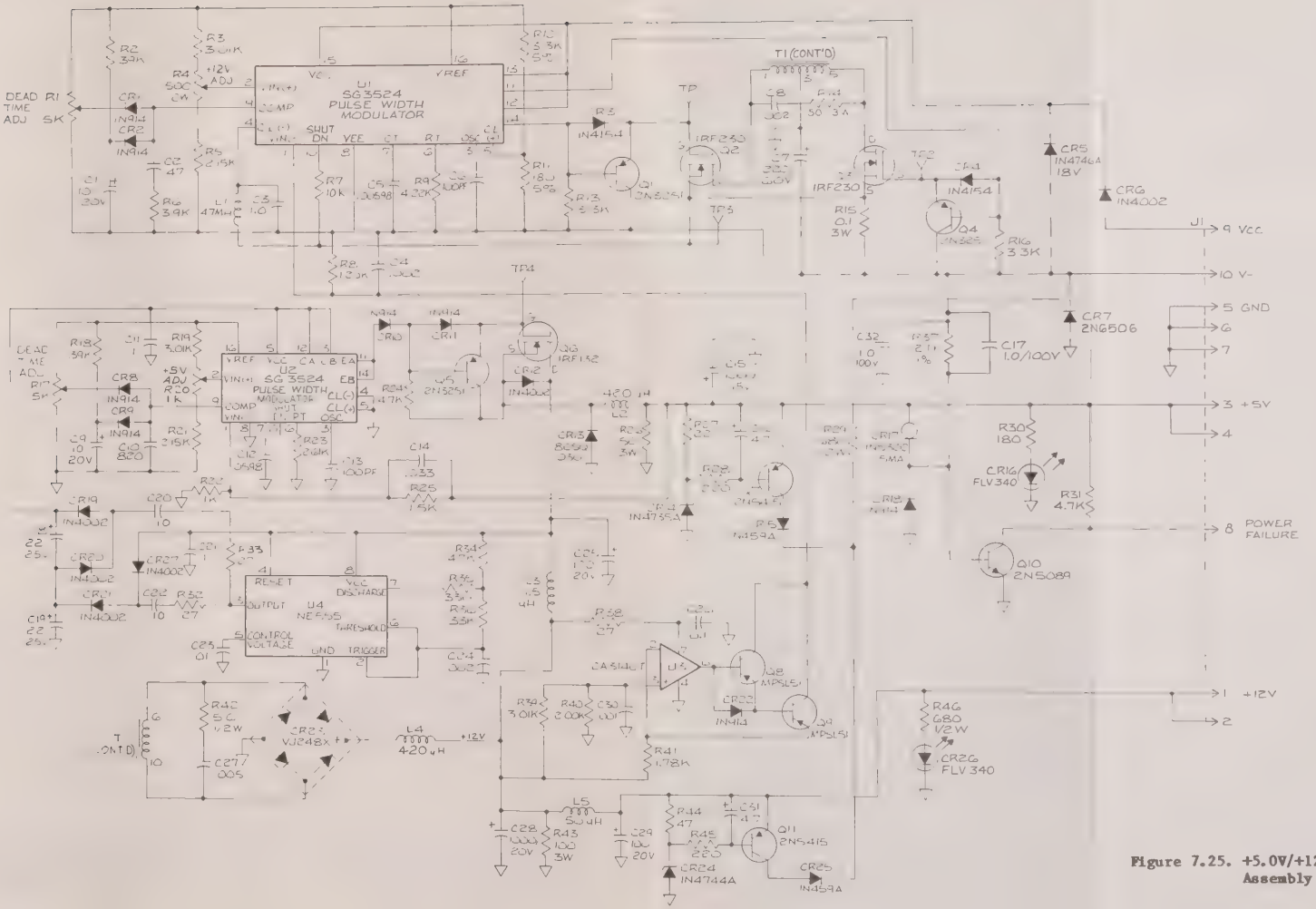


Figure 7.25. +5.0V/+12.0V Power Supply Assembly (A13), Schematic

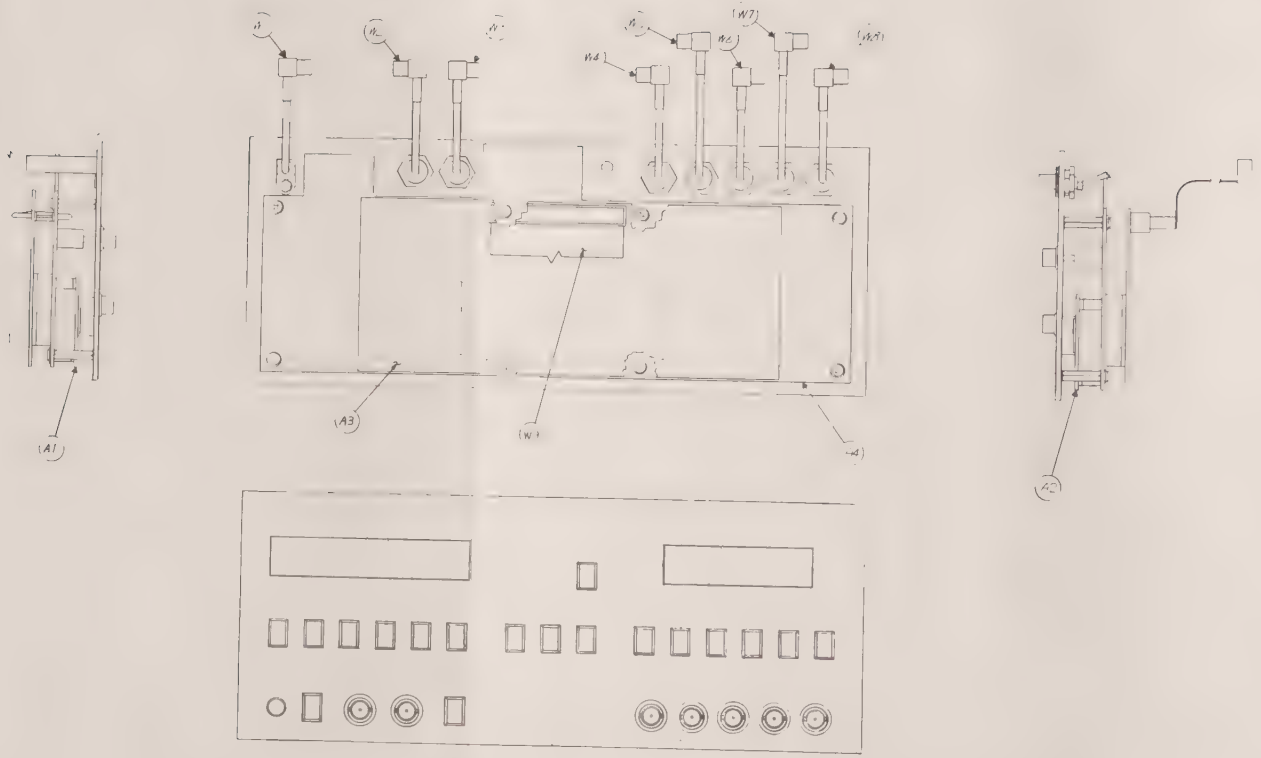


Figure 7.26. Front Panel Assembly (A14)
Cables and Component Location

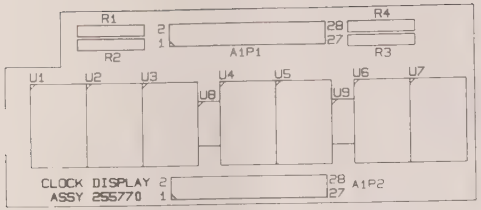


Figure 7.27. Clock Display Assembly (A14A1), Component Location

255770

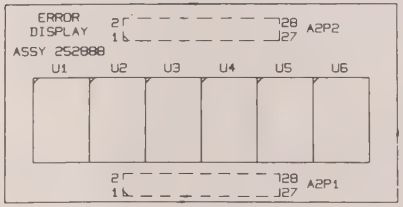


Figure 7.28. Clock Display Assembly (A14A2), Component Location

252888

35R049A

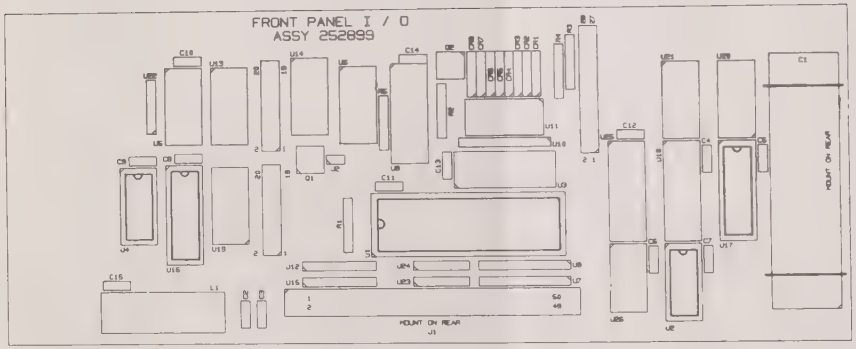


Figure 7.29. Front Panel I/O Assembly (A14A3), Component Location

252899

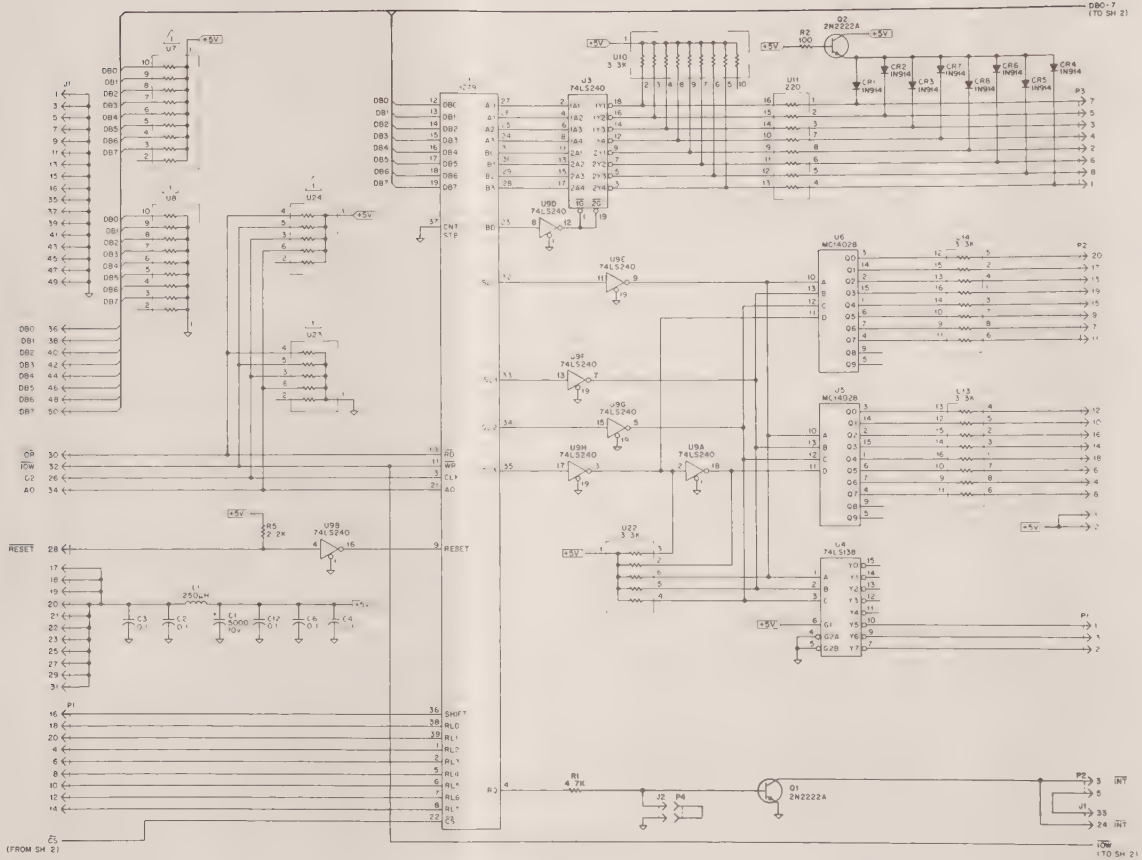
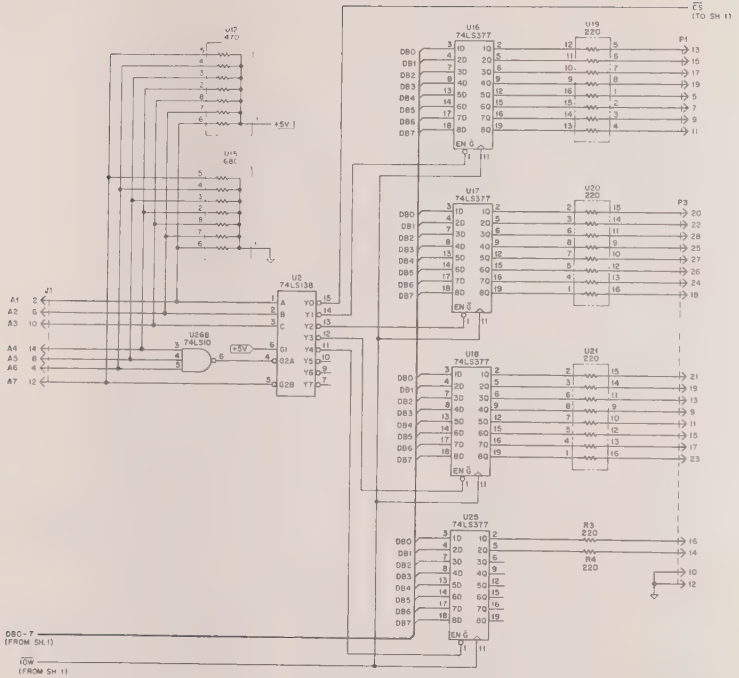
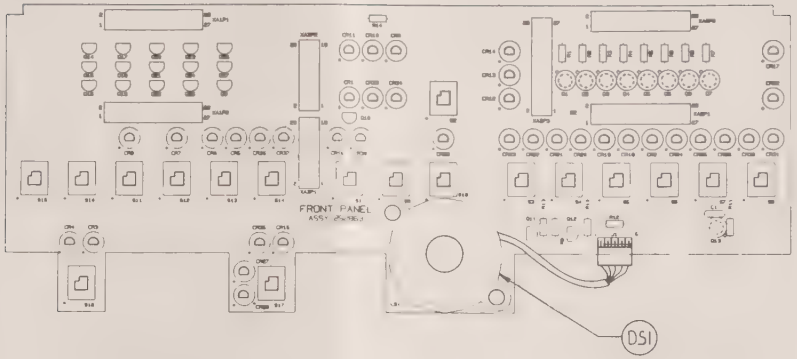


Figure 7.30. Front Panel I/O Assembly (A14A3), Schematic (Sheet 1 of 2)



IC	TYPE	+5V	GND
U1	8270	40	20
U2, U4	74LS138	16	8
U3, U9	74LS240	20	10
U5, U6	MC14028	16	8
U16, U17, U18, U25	74LS377	20	10
U26	74LS10	14	7

Figure 7.30. Front Panel I/O Assembly (A14A3), Schematic (Sheet 2 of 2)



DETAIL A

TYPICAL MOUNTING
FOR ALL CR'S (LED'S)

Figure 7.31. Front Panel Error Rate Analyzer Assembly (A14A4), Component Location

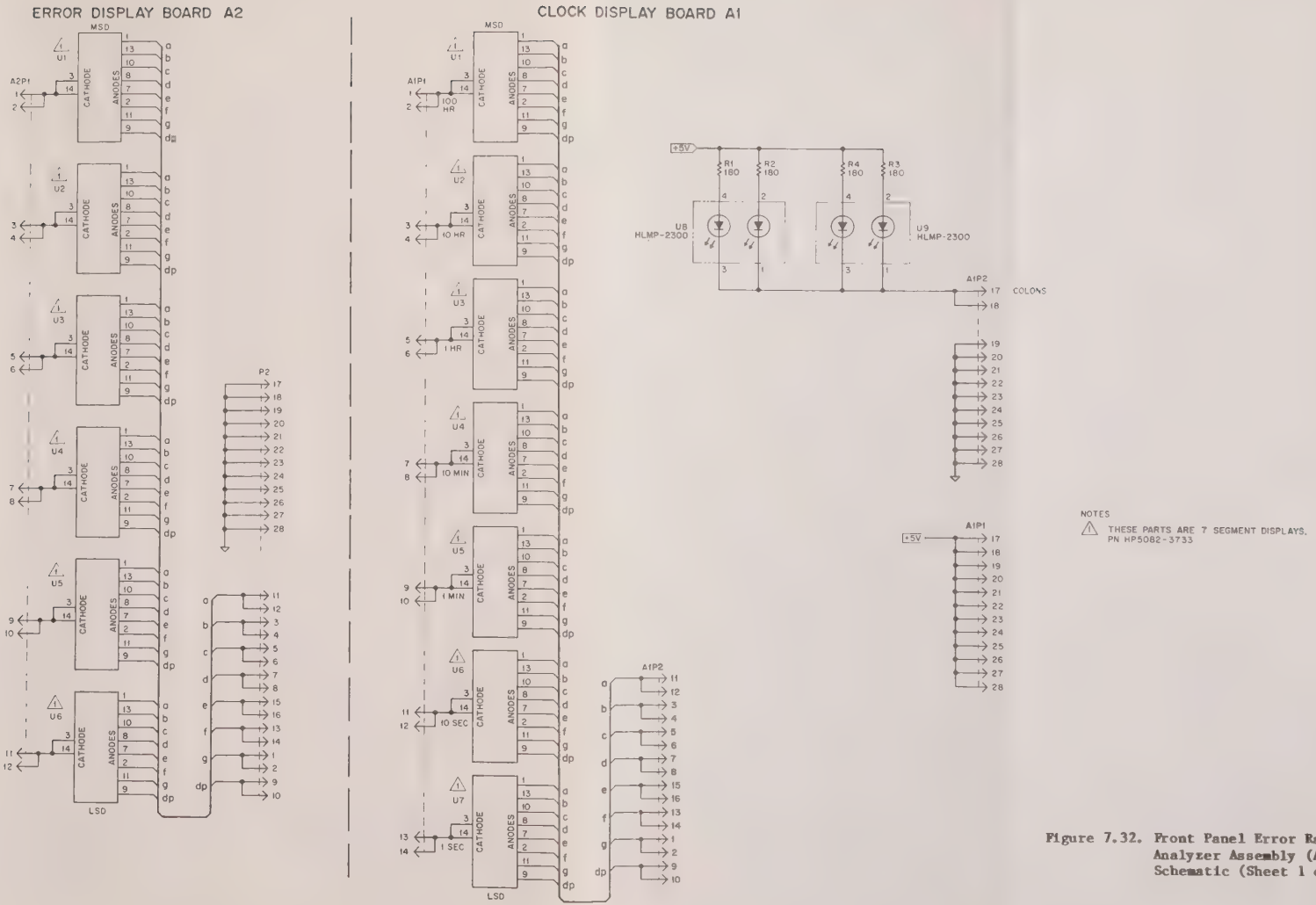


Figure 7.32. Front Panel Error Rate Analyzer Assembly (A14A4), Schematic (Sheet 1 of 3)

252861
35R049A

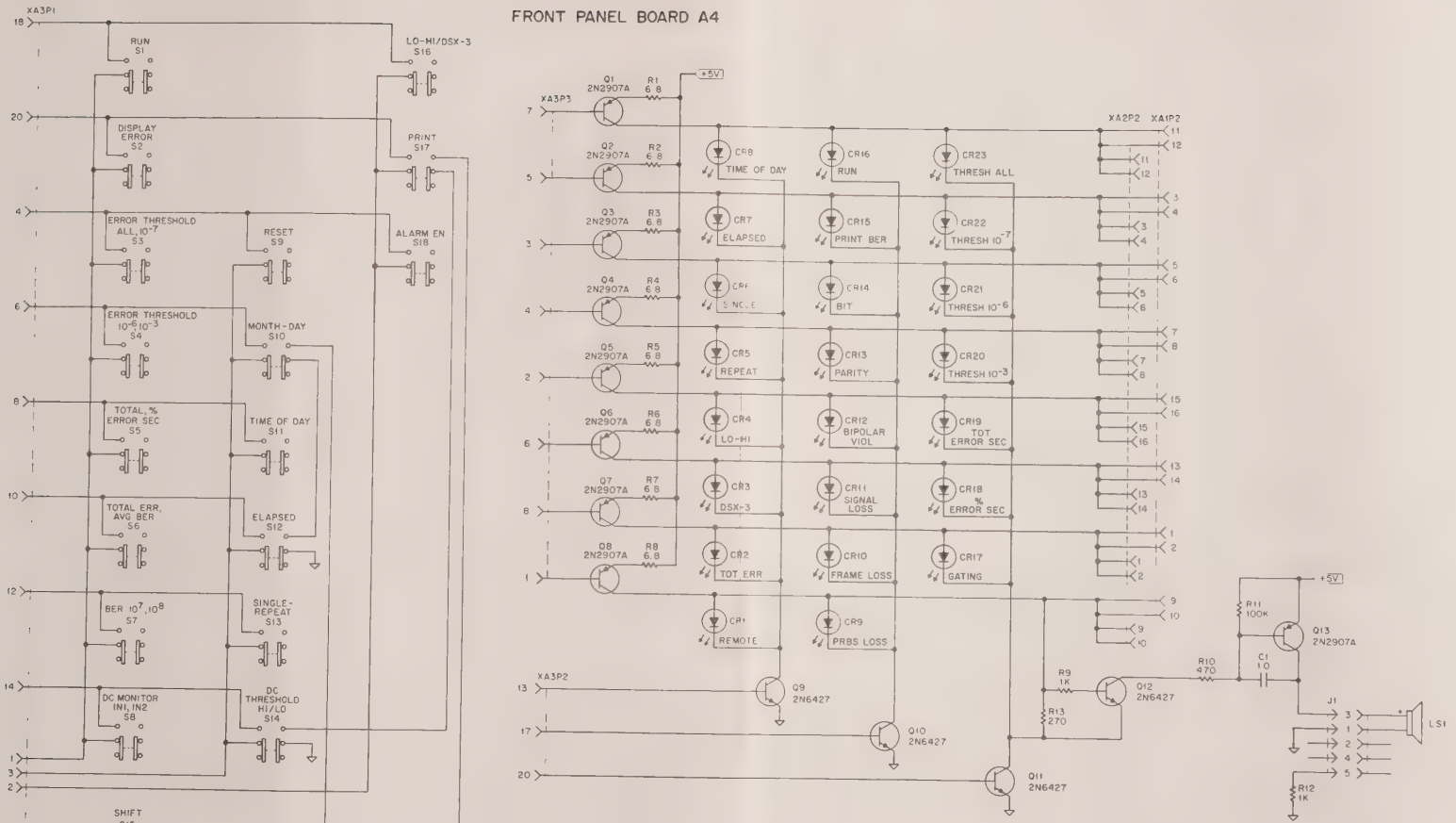


Figure 7.32. Front Panel Error Rate Analyzer Assembly (A14A4), Schematic (Sheet 2 of 3)

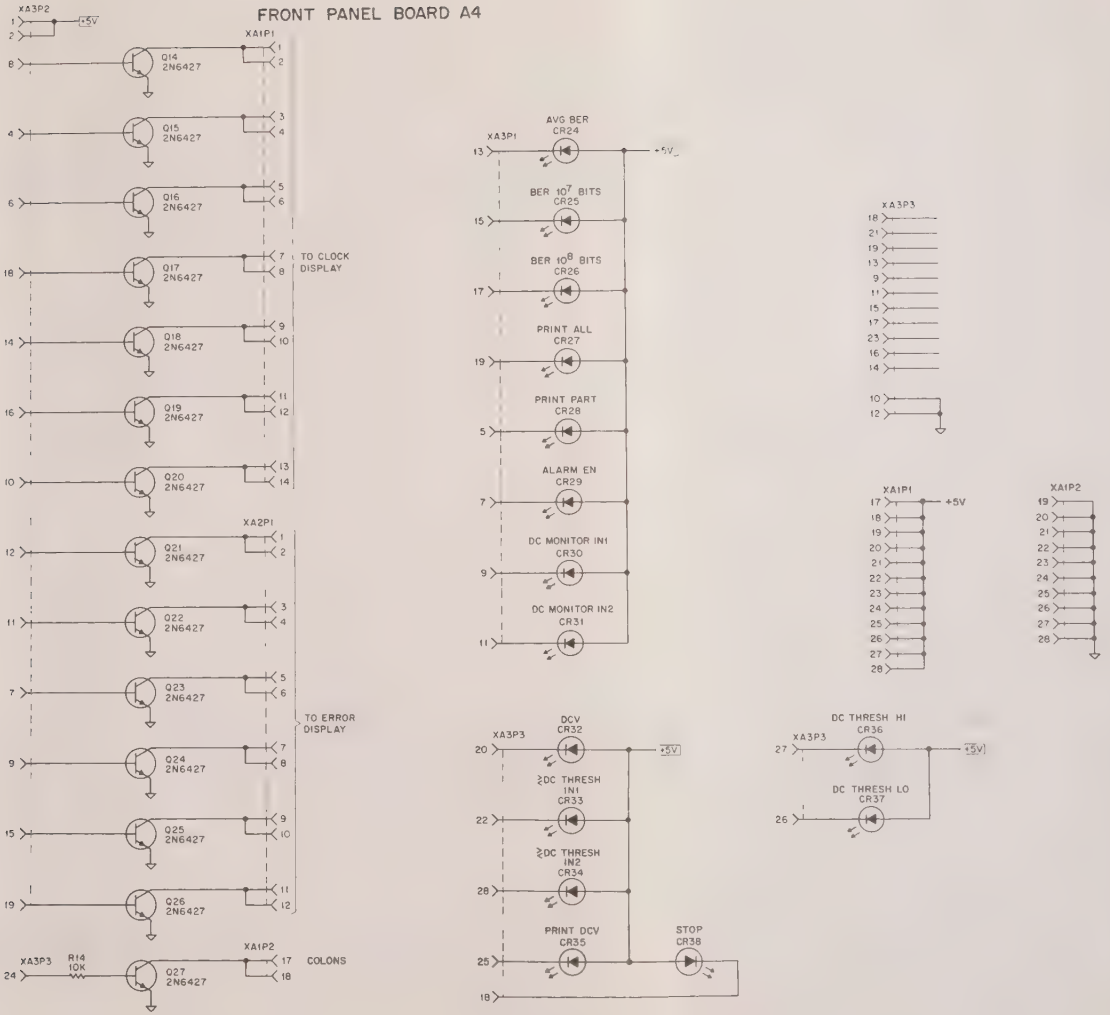


Figure 7.32. Front Panel Error Rate Analyzer Assembly (A14A4), Schematic (Sheet 3 of 3)

252861
35R049A

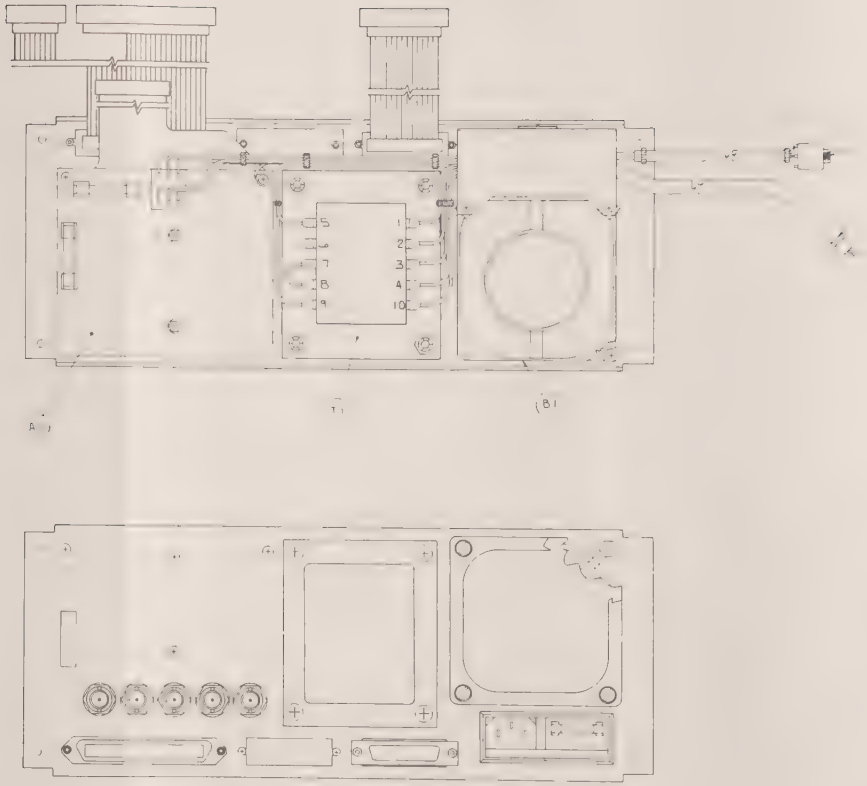


Figure 7.33. Rear Panel Assembly (A15), Component Location

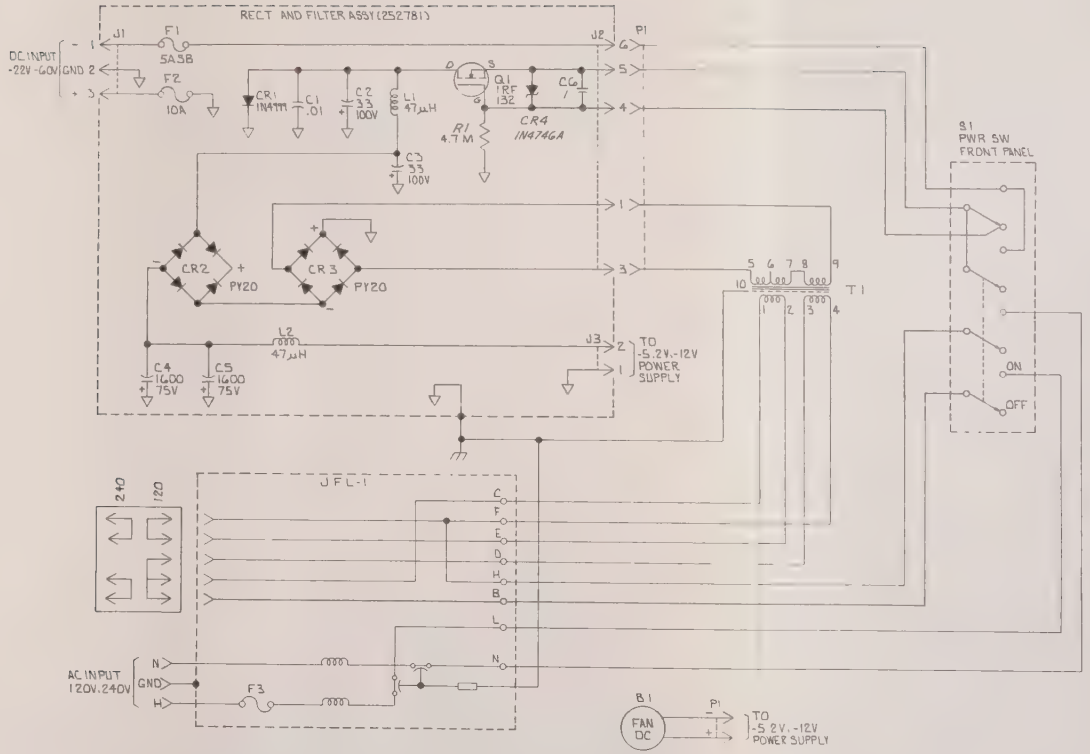
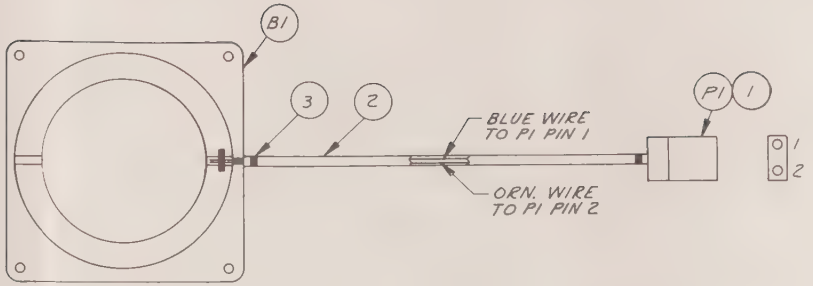


Figure 7.34. Rear Panel Assembly (A15), Schematic

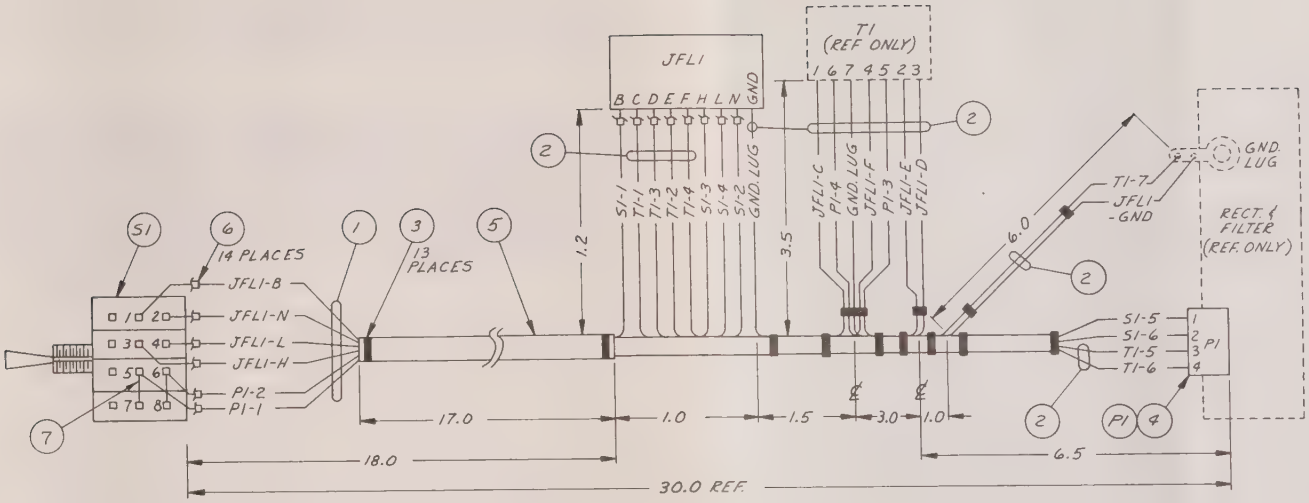
252779B
35R049A



NOTES:
1. DO NOT SHORTEN WIRES.

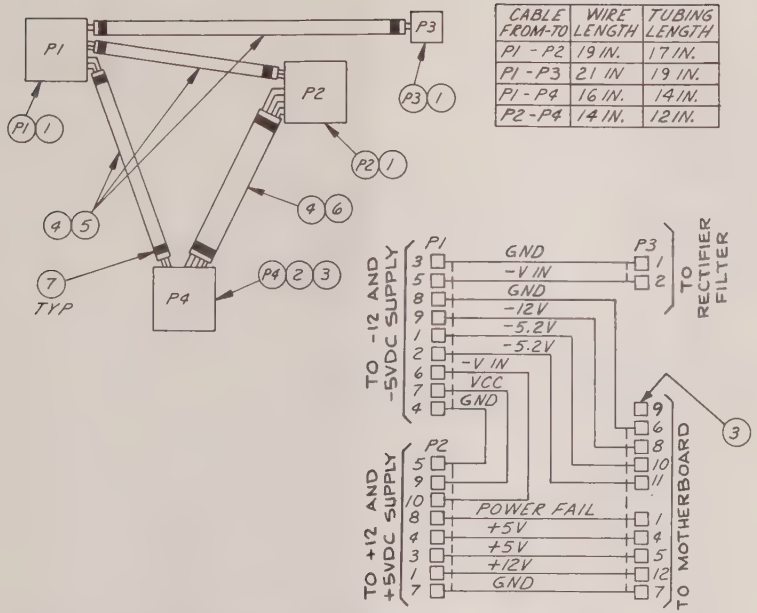
ITEM OR FIND NO	QTY REQD	S A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO.
B1	1	89647	FAN	9.5-14 VDC	
P1	1	87358	CONN. HOUSING, RECT.	2 CKT., BLUE	1-480-720-6
3	2	73045	CABLE TIE	4 IN. LONG	
2	.9FT	73212	TUBING, VINYL	8 AWG.	
1	2	86010	CONN. CONTACT, FEM.		60617-5

Figure 7.35. Rear Panel Fan Assembly (A15B1)



ITEM OR FIND NO	QTY REQD	SA STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
JFL1	1	83759	CONN., AC, 3 COND.	MALE W/FUSE BLK & FILT.	6J4
P1	1	87462	CONN. HOUSING, RECT.	POS. LOCK, 4 CKT.	1-480722-0
S1	1	170261	SWITCH, 3PDT		
7	.2FT	73318	WIRE, BUS	22 AWG	
6	.6FT	75929	TUBING, HEAT SHRINK	.125 ID	
5	1.5FT	73208	TUBING, VINYL	4 AWG	
4	4	86010	CONN. CONTACT, FEM.		60617-5
3	13	73095	CABLE TIE	4 IN. LONG	
2	7.2FT	73356	WIRE, STRD., WHT.	18 AWG	
1	11FT	73374	WIRE, STRD., WHT.	20 AWG	

Figure 7.36. Power Wiring Harness, External Power Sources



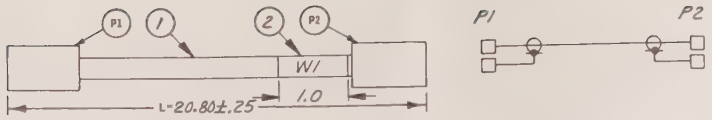
CABLE FROM-TO	WIRE LENGTH	TUBING LENGTH
P1 - P2	19 IN.	17 IN.
P1 - P3	21 IN	19 IN.
P1 - P4	16 IN.	14 IN.
P2 - P4	14 IN.	12 IN.

ITEM OR FIND NO	QTY REQD	S A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
P4	1	89674	CONN. HOUSING, RECT.	12 CKT.	1-87025-1
P3	1	87352	CONN. HOUSING, RECT.	POS. LOCK, 2 CKT.	1-480720-0
P2	1	170256	CONN. HOUSING, RECT.	FREE HNG., 10 CKT.	1-480285-2
P1	1	87046	CONN. HOUSING, RECT.	FREE HNG., 10 CKT.	1-480285-0
7	8	73045	CABLE TIES	4 IN. LONG	
6	.8FT	73207	TUBING, VINYL	2 AWG	
5	3.5FT	73212	TUBING, VINYL	8 AWG	
4	4.7FT	73356	WIRE, STRD., WHT.	18 AWG	
3	1	87429	KEY		87116-2
2	9	89565	CONN. CONTACT, FEM.		87027-3
1	19	86010	CONN. CONTACT, FEM.		60617-5

Figure 7.37. Power Wiring Harness, Internal Power Sources

220947A

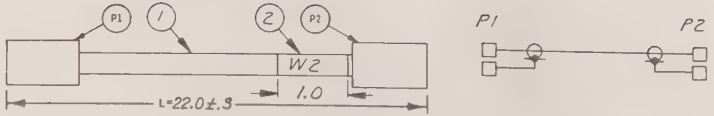
35R049A



ITEM OR FIND NO	QTY REQD	S A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
P2	1	84938	CONNECTOR, COAX	75Ω SMB	51-128-9511
P1	1	83419	CONNECTOR, COAX	MIN. PNL. JACK	J12-4
2	.1FT	85219	TUBING, HEAT SHRINK		RT-876 WHT 1/4 DIA
1	1.8FT	83156	CABLE, COAX	75Ω	8218

Figure 7.38. DS3 Input Cable Assembly (W1)

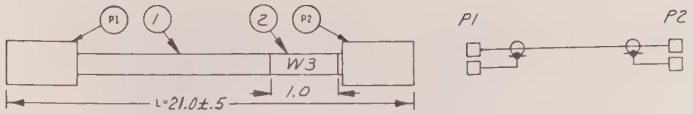
220972



ITEM OR FIND NO	QTY REQD	S A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
P2	1	84938	CONNECTOR, COAX	75Ω SMB	51-128-9511
P1	1	171567	CONNECTOR, COAX	75Ω BNC	UBJ24-4
2	.1FT	85219	TUBING, HEAT SHRINK		RT-876 WHT 1/4 DIA
1	1.9FT	83156	CABLE, COAX	75Ω	8218

Figure 7.39. NRZ Clock Input Cable Assembly (W2)

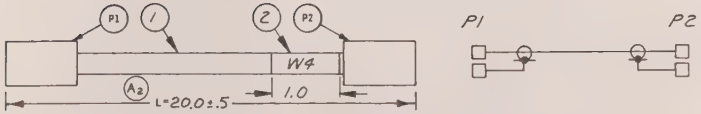
220973B



ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
P2	1	84938	CONNECTOR,COAX	75Ω SMB	51-128-9511
P1	1	171567	CONNECTOR,COAX	75Ω BNC	BJ29-4
2	.1FT	85219	TUBING,HEAT SHRINK		RT-876 WHT 1/4 DIA
1	1.8FT	83156	CABLE,COAX	75Ω	8218

Figure 7.40. NRZ Data Input Cable Assembly (W3)

220974E

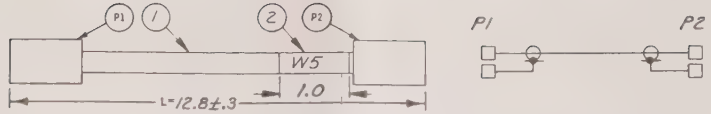


	ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
	P2	1	84938	CONNECTOR,COAX	75Ω SMB	51-128-9511
	P1	1	171567	CONNECTOR,COAX	75Ω BNC	BJ29-4
	2	.1FT	85219	TUBING,HEAT SHRINK		RT-876 WHT 1/4 DIA.
A1	1	1.7FT	83156	CABLE,COAX	75Ω	8218

Figure 7.41. X-Bit Output Cable Assembly (W4)

220975D

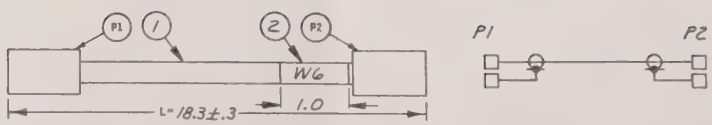
35R049A



ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
P2	1	84938	CONNECTOR,COAX	75Ω SMB	51-128-9511
P1	1	171567	CONNECTOR,COAX	75Ω BNC	BJ29-4
2	.1FT	85219	TUBING,HEAT SHRINK		RT-876 WHT 1/4 DIA
1	1.1FT	83156	CABLE,COAX	75Ω	8218

Figure 7.42. Gapped Clock Cable Assembly (W5)

220976C

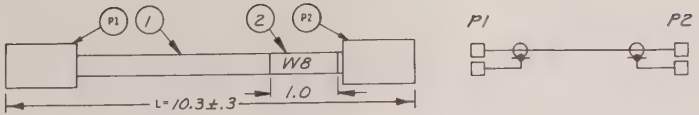


ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
P2	1	84938	CONNECTOR,COAX	75Ω SMB	51-128-9511
P1	1	171567	CONNECTOR,COAX	75Ω BNC	BJ29-4
2	.1FT	85219	TUBING,HEAT SHRINK		RT-876 WHT 1/4 DIA
1	1.6FT	83156	CABLE,COAX	75Ω	8218

Figure 7.43. Data Output Cable Assembly (W6)

220977C

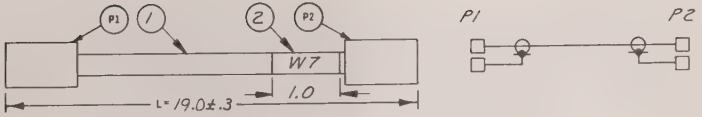
4657



ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
P2	1	84938	CONNECTOR, COAX	75Ω SMB	51-128-9511
P1	1	171567	CONNECTOR, COAX	75Ω BNC	BJ29-4
2	.1FT	85219	TUBING, HEAT SHRINK		RT-876 WHT 1/4 DIA
1	9FT	83156	CABLE, COAX	75Ω	8218

Figure 7.44. M-Sync Output Cable Assembly (W7)

220979C

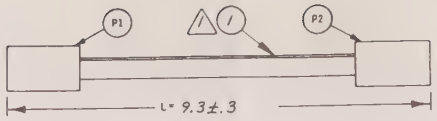


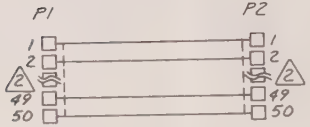
ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
P2	1	84938	CONNECTOR, COAX	75Ω SMC	51-128-9511
P1	1	171567	CONNECTOR, COAX	75Ω BNC	BJ29-4
2	.1FT	85219	TUBING, HEAT SHRINK		RT-876 WHT 1/4 DIA
1	1.6FT	83156	CABLE, COAX	75Ω	8218

Figure 7.45. Error Output Cable Assembly (W8)

220978D

35R049A





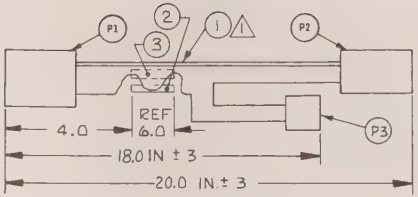
NOTES:

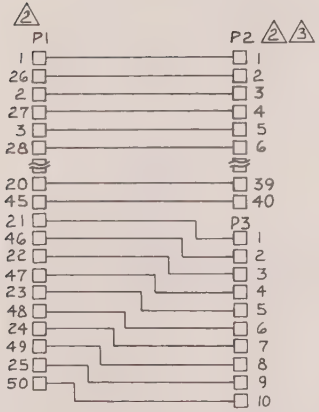
1. RED LINE DENOTES PIN 1.
2. PINS ON P1 CONNECTED TO IDENTICAL PINS ON P2.

ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
P2	1	87029	CONN. FLAT, 50 PIN	FEM.	
P1	1	87029	CONN. FLAT, 50 PIN	FEM.	
1	.8FT	84305	CABLE, FLAT, 50 COND.	28 AWG	

Figure 7.46. Front Panel I/O Cable Assembly (W9)

220980





NOTES:

1. RED LINE DENOTES PIN 1 OF P1 & P2.
2. P2 ODD NO. PINS CONNECT TO P1 PINS 1-20. P2 EVEN NO. PINS CONNECT TO P1 PINS 26-45. P3 CONNECTS AS INDICATED.
3. P2 PINS 41-50 NOT USED.

ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
3	.5 FT	76216	TAPE SPRING	.187 THK x 1.0 WIDE	
2	.5 FT	76216	TAPE SPRING	.187 THK x 1.0 WIDE	
P3	1	85048	CONN., FLAT CABLE, FEM.	10 PIN	86981-2
P2	1	87029	CONN., FLAT CABLE, FEM.	50 PIN	86916-2
P1	1	171595	CONN, FLAT CABLE, FEM.	50 PIN	3565-1000
1	1.7 FT	84305	CABLE, FLAT	50 COND.	

Figure 7.47. Local Printer (Model 4650) Interface Cable Assembly (W10)

220983C
35R049A

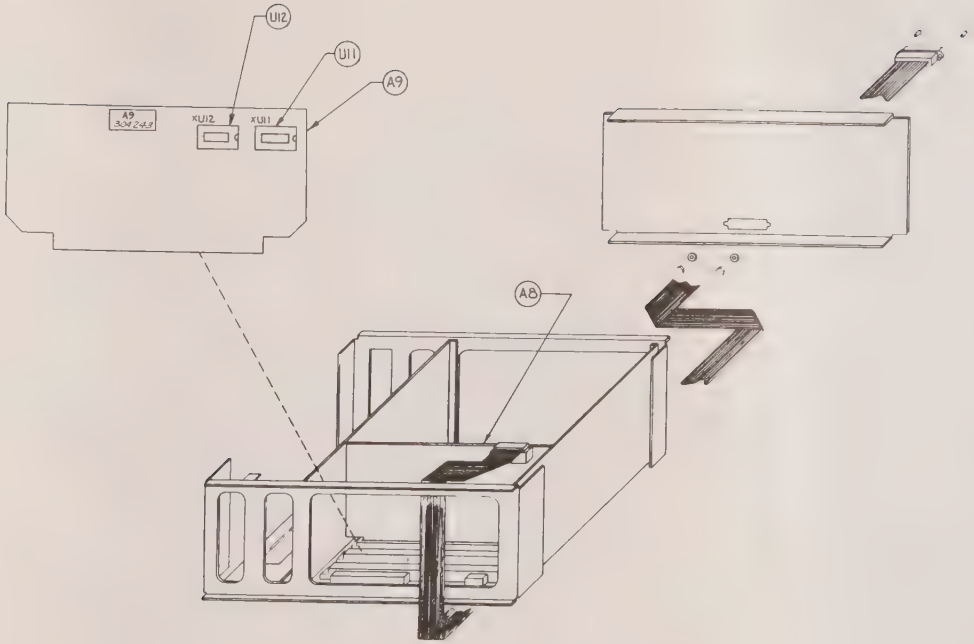
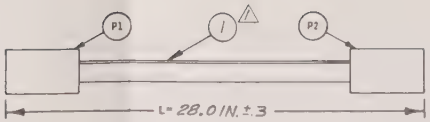
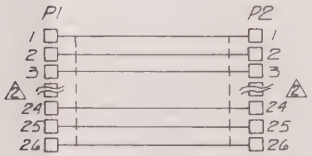


Figure 7.48. Optional IEEE-488 Interface, Installation Assembly Diagram





NOTES:
1. RED LINE DENOTES PIN 1.
2. PINS ON P1 CONNECTED TO IDENTICAL PINS ON P2.

ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
P2	1	89630	CONN, FLAT CABLE	24 PIN	1-88377-0
P1	1	88369	CONN, FLAT CABLE	24 PIN	552840-1
1	24FT	88367	CABLE, FLAT RIBBON	24 COND	

Figure 7.49. Optional IEEE-488 Interface Cable Assembly (W12)

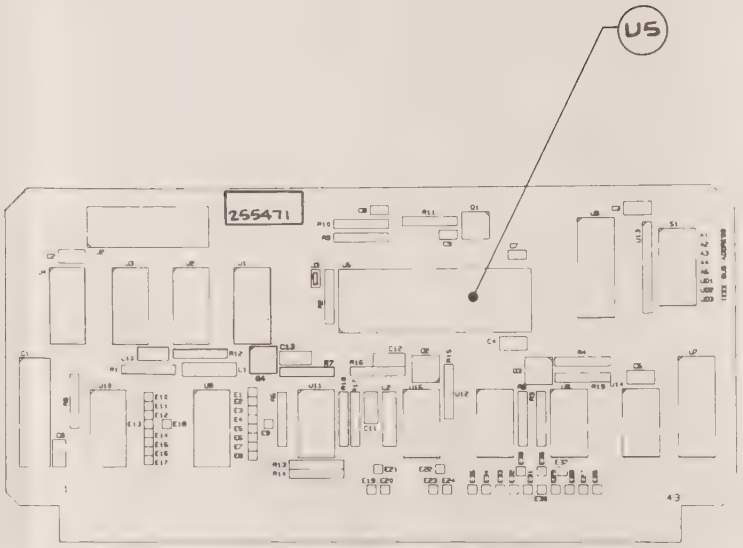
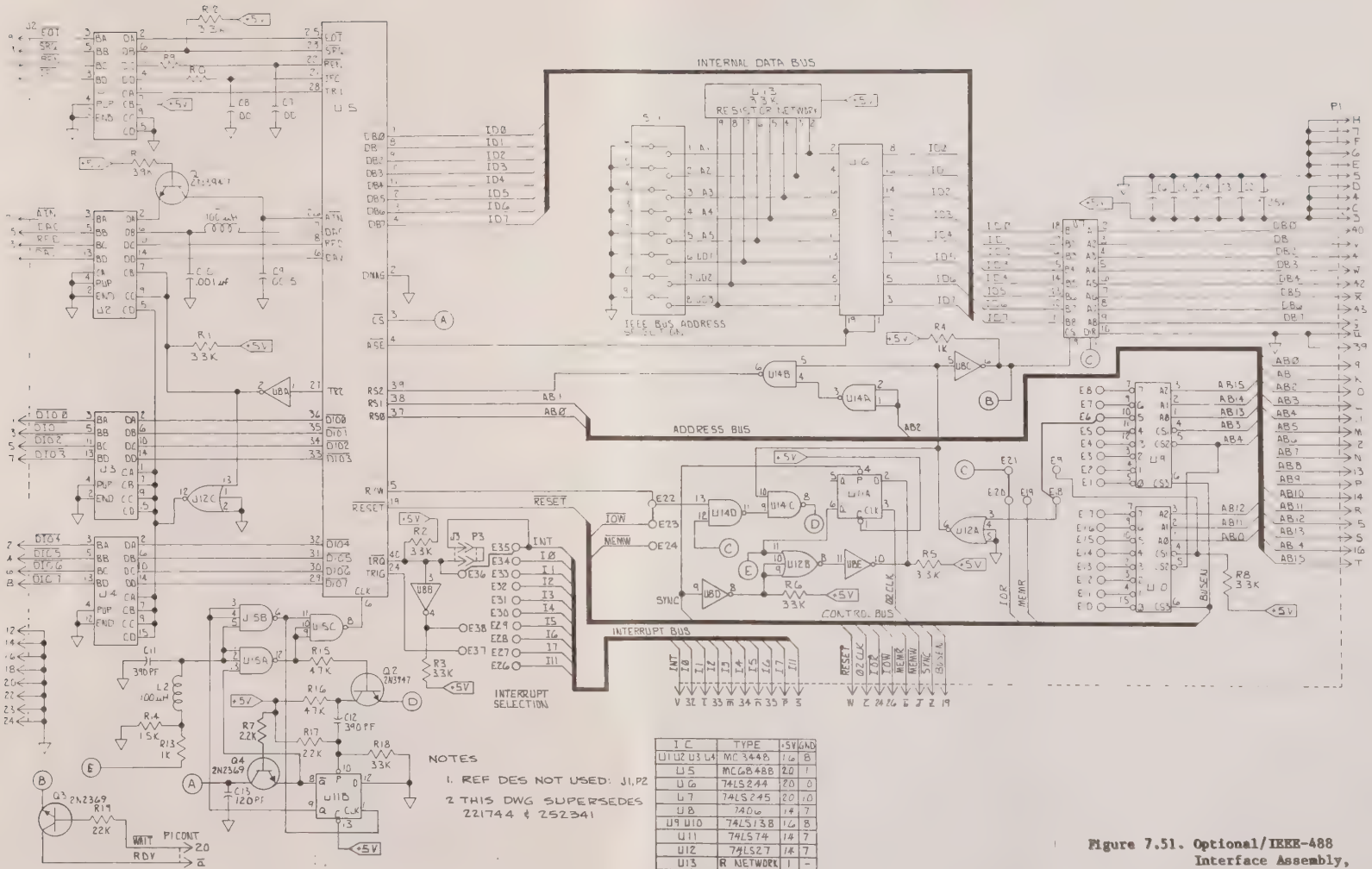


Figure 7.50. Optional IEEE-488 Interface Assembly, Component Location



NOTES

1. REF DES NOT USED: J1, P2
2. THIS DWG SUPERSEDES 221744 & 252341

I C	TYPE	+5V	GND
U1 U2 U3 U4	MC 3448	16	8
U5	MC6B488	20	1
U6	74LS244	20	10
U7	74LS245	20	10
U8	7406	14	7
U9 U10	74LS138	16	8
U11	74LS74	14	7
U12	74LS27	14	7
U13	R NETWORK	1	-
U14	74LS00	14	7
U15	74S310	14	7

Figure 7.51. Optional/IEEE-488 Interface Assembly, Schematic

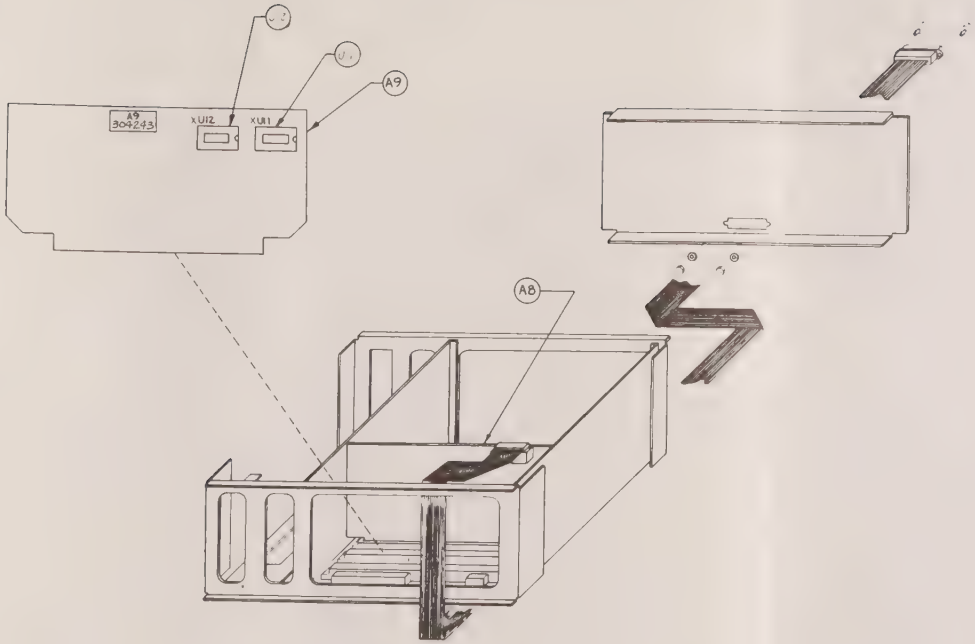
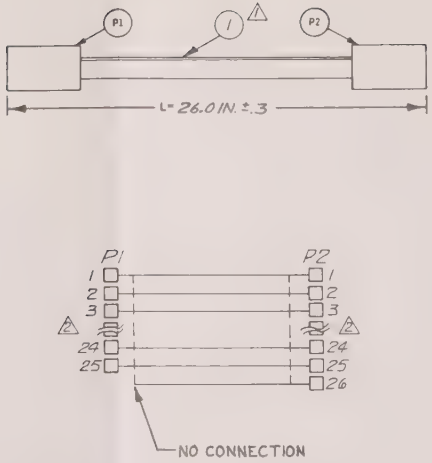


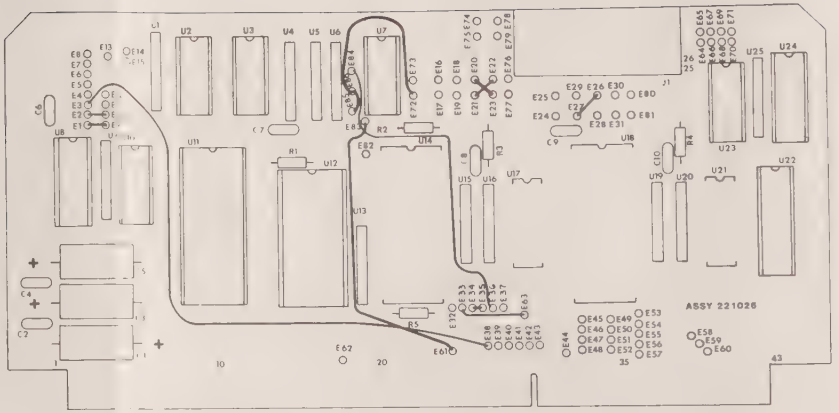
Figure 7.52. Optional RS-232C Interface, Installation Assembly Diagram



NOTES:
1. RED LINE DENOTES PIN 1.
2. PINS ON P1 CONNECTED TO IDENTICAL PINS ON P2.

ITEM OR FIND NO	QTY REQD	SA STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
P2	1	170223	CONN, FLAT FEMALE	26 PIN	88377-5
P1	1	86242	CONN, FLAT FEMALE	FLAT CABLE 25 1026 PIN COND	206770-1
1	22FT	82495	CABLE, FLAT RIBBON	26 COND	

Figure 7.53. Optional RS-232C Interface Cable Assembly

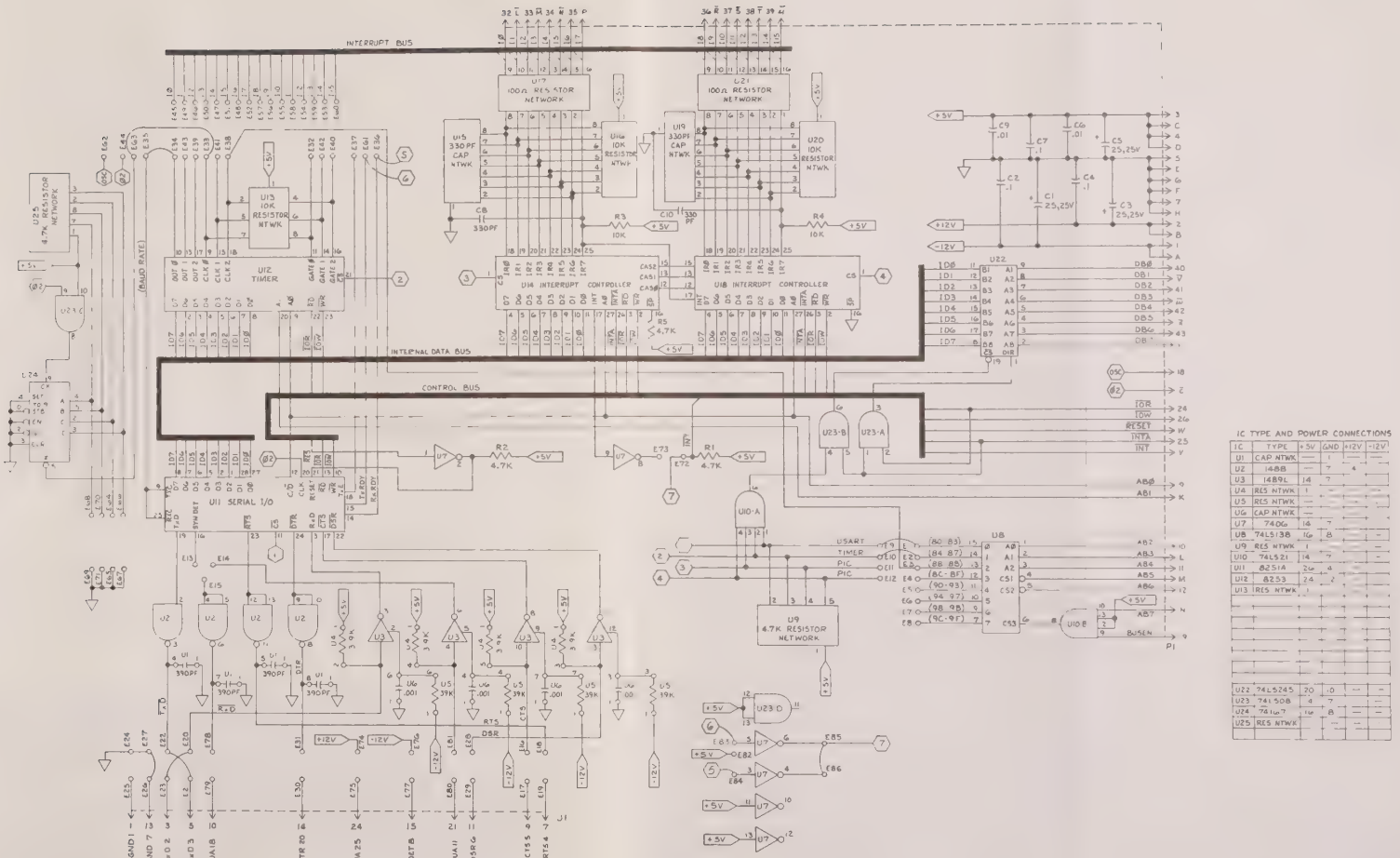


△3 JUMPER INSTALLATION CHART

FROM	TO
E1	E9
E2	E10
E3	E38
E20	E23
E21	E22
E26	E27
E33	E63
E34	E35
E72	E86
E85	E86
E61	E83
E36	E84

NOTES:
1. C8,C10,R3,R4,R5,U14-U21 SHOWN ON SILKSCREEN BUT NOT INSTALLED.
2. REFERENCE DESIGNATIONS NOT USED:
△3 JUMPERS, ITEM 2, TO BE INSTALLED PER CHART.

Figure 7.54. Optional RS-232C Interface Assembly, Component Location



IC TYPE AND POWER CONNECTIONS

IC	TYPE	+5V	GND	+12V	-12V
U1	CAP NTWK	—	1	—	—
U2	1488	—	7	4	—
U3	1489L	14	7	—	—
U4	RES NTWK	1	—	—	—
U5	RES NTWK	—	—	—	—
U6	CAP NTWK	—	—	—	—
U7	7406	14	7	—	—
U8	74LS138	16	8	—	—
U9	RES NTWK	1	—	—	—
U10	74LS21	14	7	—	—
U11	8251A	26	4	—	—
U12	8253	24	2	—	—
U13	RES NTWK	1	—	—	—
U22	74LS245	20	10	—	—
U23	74LS08	4	7	—	—
U24	74107	14	8	—	—
U25	RES NTWK	—	—	—	—

Figure 7.55. Optional RS-232C Interface Assembly, Schematic

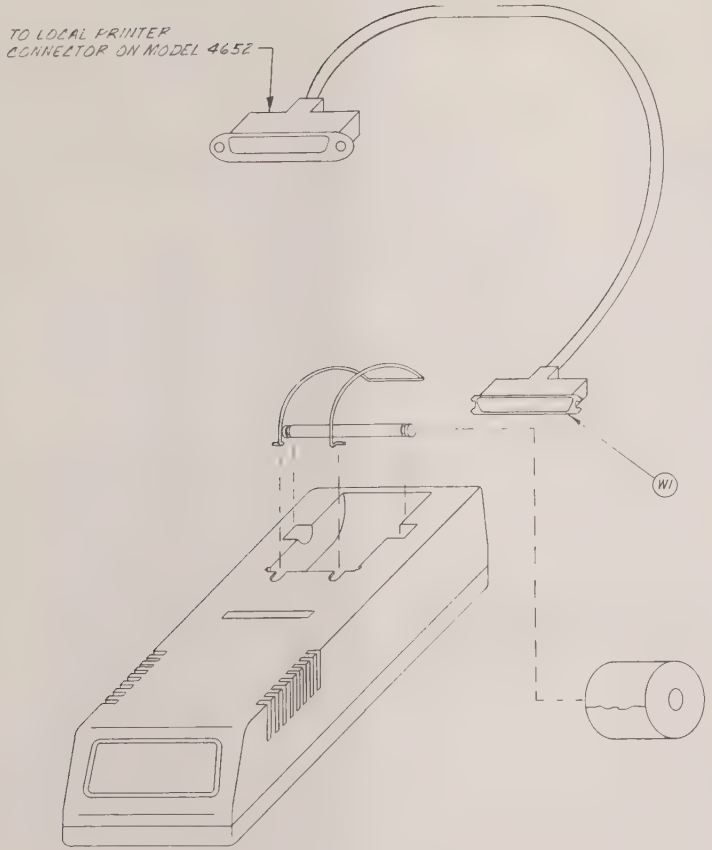
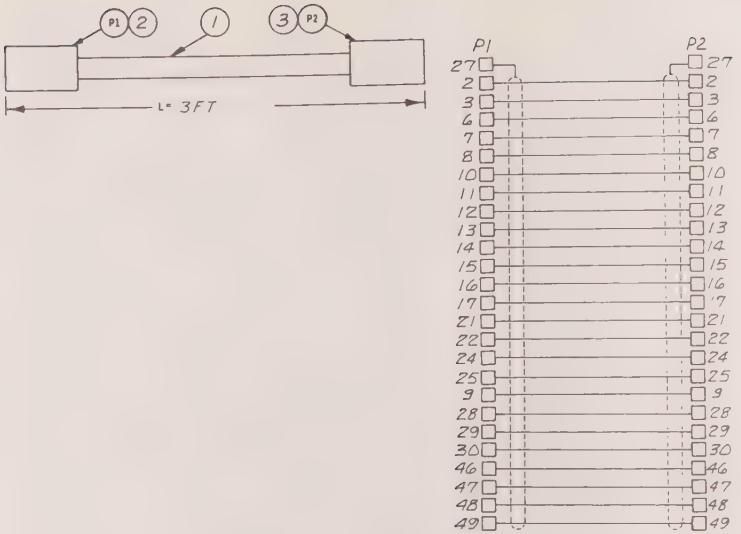


Figure 7.56. Model 4650 Optional Local Printer Components

221020A

35R049A



ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
P2	1	89676	CONN, RECT MALE	50 CONTACTS	552032-1
P1	1	89676	CONN, RECT MALE	50 CONTACTS	552032-1
3	1	85908	CONN, STRAIN RELIEF	STRAIGHT	2-552008-1
2	1	89677	CONN, STRAIN RELIEF	90°	552014-1
1	3FT	170216	CABLE, SHIELDED	25 COND AWG 24	9543

Figure 7.57. Model 4650 Optional Local Printer Cable Assembly (W1)

221005B

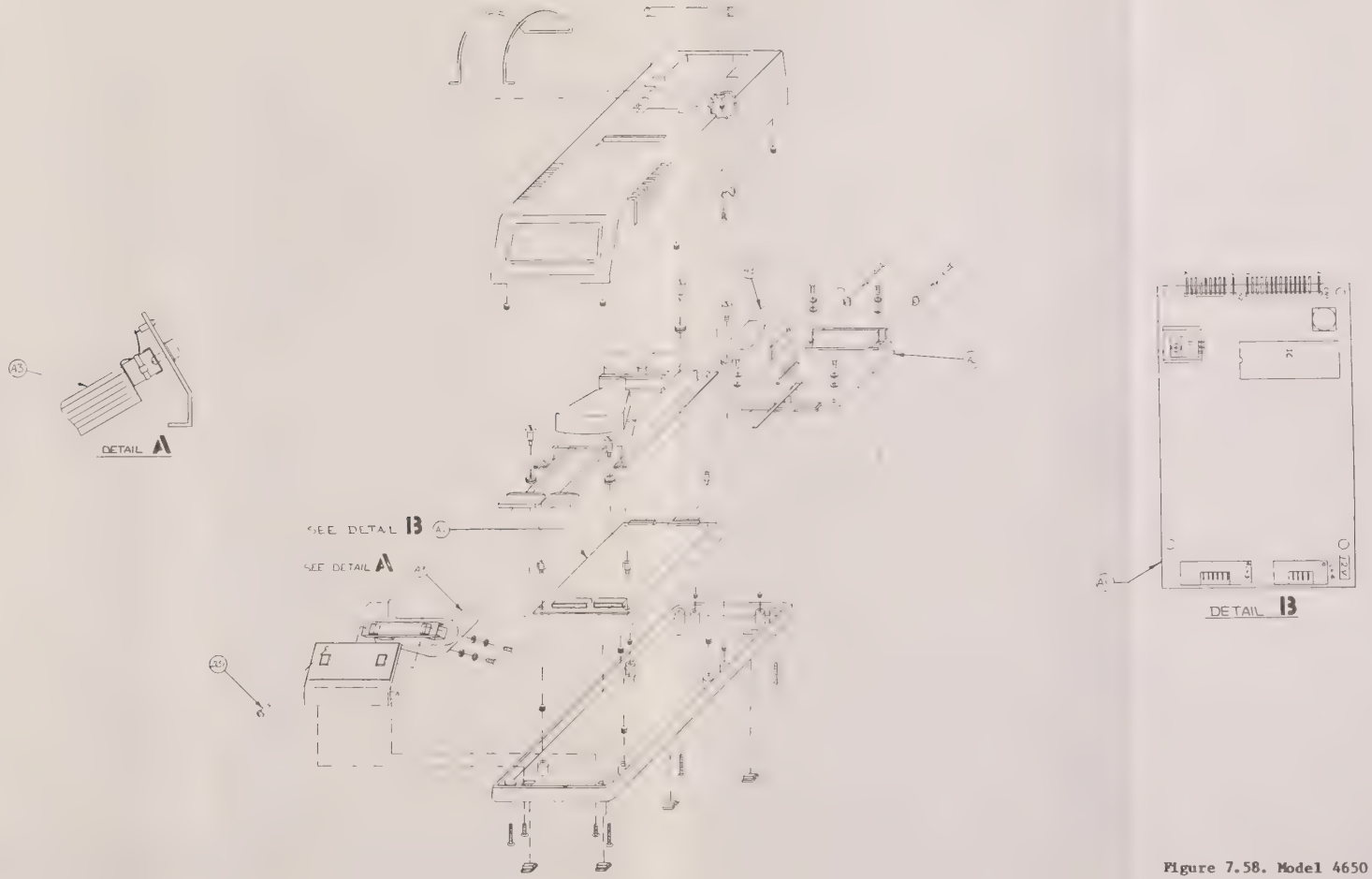


Figure 7.58. Model 4650 Optional Local Printer Mechanical Layout

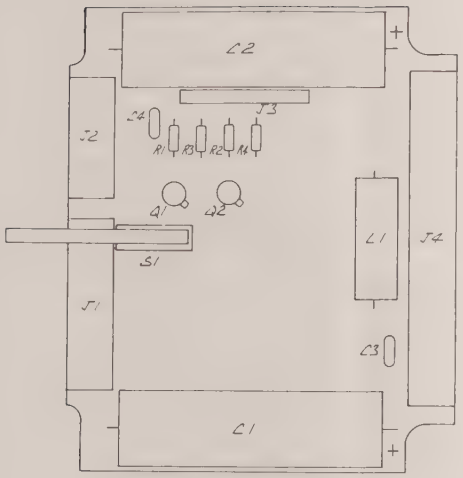


Figure 7.59. Model 4650 Optional Local Printer I/O Assembly, Component Location

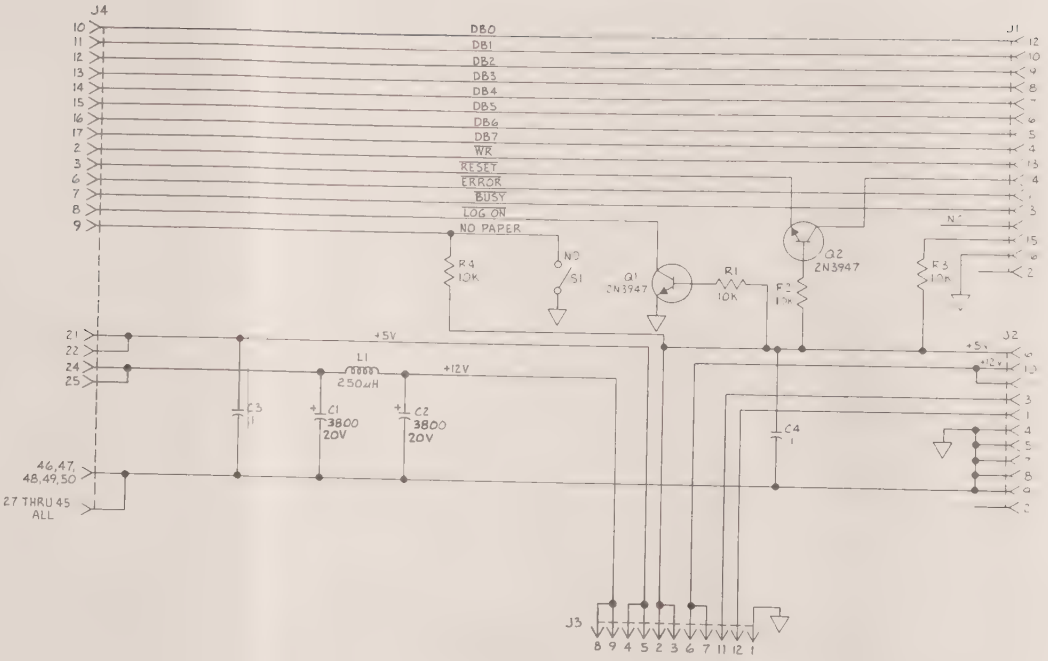


Figure 7.60. Model 4650 Optional Local Printer I/O Assembly, Schematic

221002

35R049A

221001A

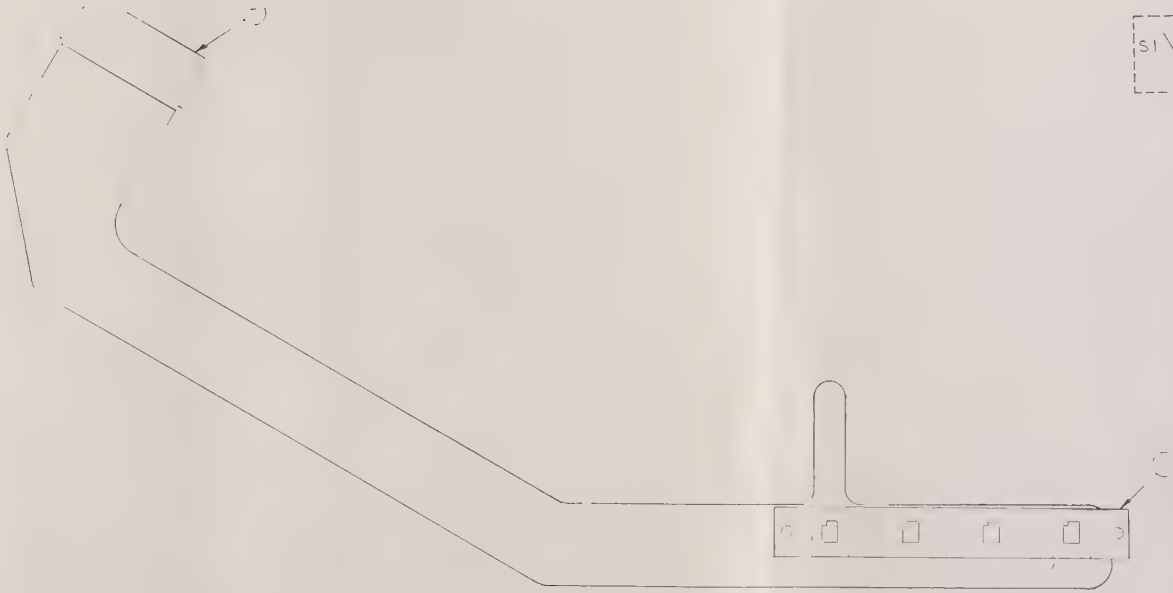


Figure 7.61. Model 4650 Optional Local Printer Flexible Assembly, Component Location

220999

35R049A

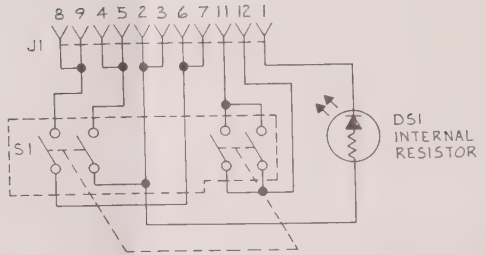
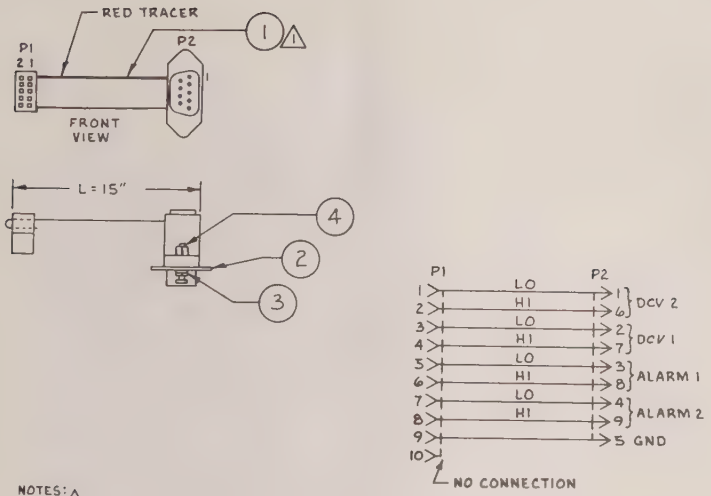


Figure 7.62. Model 4650 Optional Local Printer Flexible Assembly, Schematic

220998



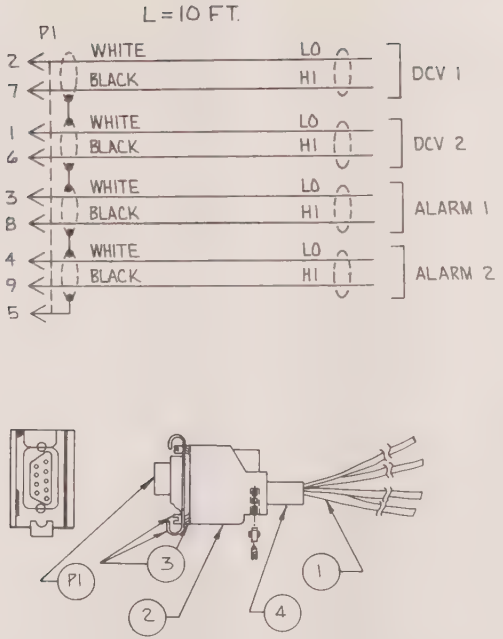
NOTES:
1. RED TRACER INDICATES PIN 1.

ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
4	AR	85339	ADHESIVE & SEALANT		290-31
3	2	74046	CONN,RECT LOCK POST	SIZE E	D53018
2	1	257136	PLATE,CONN ADAPTER		
1	1	85130	CABLE,FLT	10 COND 28AWG	3365/10
P2	1	89405	CONN,FLT CABLE	9 PIN	49-1109P
P1	1	85048	CONN,FLT CABLE	10 PIN	86981-2

Figure 7.63. Cable Assembly, DCV/ALARM Optional Rear Panel

257137

35R049A



ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
4	IFT	77938	TUBING, HEATSHRINK	.375 ID	FIT-221-3/8 BLK
3	1	173622	CONN,RECT SLIDINGLOCK	SIZE E	DE-51224-1
2	1	173623	CONN. RECT SHELL	SIZE E	DE-51218-1
1	24	78027	CABLE, FOIL SHIELD	2 COND 26 AWG	
P1	1	78944	CONN RECT FEMALE	9 COND	17-80090-16

Figure 7.64. Cable Assembly, DVC/ALARM Mon

252859

CONVERSION OF VOLTAGE AND POWER RATIOS TO DECIBELS

The basic chart below indicates the number of decibels (dB) corresponding to the listed ratios of voltage or power over the range of −20 to +20 dB. For voltage or power ratios greater than those included in the chart, the ratio can be broken down into a product of two numbers, the value in dB for each found separately, and the two results added. Example: To convert a power ratio of 2,000:1 to dB, express 2,000 as 2×10^3; the number of dB corresponding to a power ratio of 2 is very nearly 3, and the number of dB for a power ratio of 10^3 is 30. Therefore, the power ratio of 2,000:1 is approximately 30 dB + 3 dB = 33 dB. In the lower righthand corner of the chart dB values for voltage and power ratios of integral powers of 10 are given.

Voltage Ratio	Power Ratio	−dB+	Voltage Ratio	Power Ratio	Voltage Ratio	Power Ratio	−dB+	Voltage Ratio	Power Ratio	Voltage Ratio	Power Ratio	−dB+	Voltage Ratio	Power Ratio
1.000	**1.000**	**0**	**1.000**	**1.000**	**.447**	**.200**	**7.0**	**2.239**	**5.012**	**.200**	**.0398**	**14.0**	**5.012**	**25.12**
.989	.977	.1	1.012	1.023	.442	.195	7.1	2.265	5.129	.197	.0389	14.1	5.070	25.70
.977	.955	.2	1.023	1.047	.437	.191	7.2	2.291	5.248	.195	.0380	14.2	5.129	26.30
.966	.933	.3	1.035	1.072	.432	.186	7.3	2.317	5.370	.193	.0372	14.3	5.188	26.92
.955	.912	.4	1.047	1.096	.427	.182	7.4	2.344	5.495	.191	.0363	14.4	5.248	27.54
.944	.891	.5	1.059	1.122	.422	.178	7.5	2.371	5.623	.188	.0355	14.5	5.309	28.18
.933	.871	.6	1.072	1.148	.417	.174	7.6	2.399	5.754	.186	.0347	14.6	5.370	28.84
.923	.851	.7	1.084	1.175	.412	.170	7.7	2.427	5.888	.184	.0339	14.7	5.433	29.51
.912	.832	.8	1.096	1.202	.407	.166	7.8	2.455	6.026	.182	.0331	14.8	5.495	30.20
.902	.813	.9	1.109	1.230	.403	.162	7.9	2.483	6.166	.180	.0324	14.9	5.559	30.90
.891	**.794**	**1.0**	**1.122**	**1.259**	**.398**	**.159**	**8.0**	**2.512**	**6.310**	**.178**	**.0316**	**15.0**	**5.623**	**31.62**
.881	.776	1.1	1.135	1.288	.394	.155	8.1	2.541	6.457	.176	.0309	15.1	5.689	32.36
.871	.759	1.2	1.148	1.318	.389	.151	8.2	2.570	6.607	.174	.0302	15.2	5.754	33.11
.861	.741	1.3	1.161	1.349	.385	.148	8.3	2.600	6.761	.172	.0295	15.3	5.821	33.88
.851	.724	1.4	1.175	1.380	.380	.145	8.4	2.630	6.918	.170	.0288	15.4	5.888	34.67
.841	.708	1.5	1.189	1.413	.376	.141	8.5	2.661	7.079	.168	.0282	15.5	5.957	35.48
.832	.692	1.6	1.202	1.445	.372	.138	8.6	2.692	7.244	.166	.0275	15.6	6.026	36.31
.822	.676	1.7	1.216	1.479	.367	.135	8.7	2.723	7.413	.164	.0269	15.7	6.095	37.15
.813	.661	1.8	1.230	1.514	.363	.132	8.8	2.754	7.586	.162	.0263	15.8	6.166	38.02
.804	.646	1.9	1.245	1.549	.359	.129	8.9	2.786	7.762	.160	.0257	15.9	6.237	38.90
.794	**.631**	**2.0**	**1.259**	**1.585**	**.355**	**.126**	**9.0**	**2.818**	**7.943**	**.159**	**.0251**	**16.0**	**6.310**	**39.81**
.785	.617	2.1	1.274	1.622	.351	.123	9.1	2.851	8.128	.157	.0246	16.1	6.383	40.74
.776	.603	2.2	1.288	1.660	.347	.120	9.2	2.884	8.318	.155	.0240	16.2	6.457	41.69
.767	.589	2.3	1.303	1.698	.343	.118	9.3	2.917	8.511	.153	.0234	16.3	6.531	42.66
.759	.575	2.4	1.318	1.738	.339	.115	9.4	2.951	8.710	.151	.0229	16.4	6.607	43.65
.750	.562	2.5	1.334	1.778	.335	.112	9.5	2.985	8.913	.150	.0224	16.5	6.683	44.67
.741	.550	2.6	1.349	1.820	.331	.110	9.6	3.020	9.120	.148	.0219	16.6	6.761	45.71
.733	.537	2.7	1.365	1.862	.327	.107	9.7	3.055	9.333	.146	.0214	16.7	6.839	46.77
.724	.525	2.8	1.380	1.905	.324	.105	9.8	3.090	9.550	.145	.0209	16.8	6.918	47.86
.716	.513	2.9	1.396	1.950	.320	.102	9.9	3.126	9.772	.143	.0204	16.9	6.998	48.98
.708	**.501**	**3.0**	**1.413**	**1.995**	**.316**	**.100**	**10.0**	**3.162**	**10.000**	**.141**	**.0200**	**17.0**	**7.079**	**50.12**
.700	.490	3.1	1.429	2.042	.313	.0977	10.1	3.199	10.23	.140	.0195	17.1	7.161	51.29
.692	.479	3.2	1.445	2.089	.309	.0955	10.2	3.236	10.47	.138	.0191	17.2	7.244	52.48
.684	.468	3.3	1.462	2.138	.306	.0933	10.3	3.273	10.72	.137	.0186	17.3	7.328	53.70
.676	.457	3.4	1.479	2.188	.302	.0912	10.4	3.311	10.96	.135	.0182	17.4	7.413	54.95
.668	.447	3.5	1.496	2.239	.299	.0891	10.5	3.350	11.22	.133	.0178	17.5	7.499	56.23
.661	.437	3.6	1.514	2.291	.295	.0871	10.6	3.388	11.48	.132	.0174	17.6	7.586	57.54
.653	.427	3.7	1.531	2.344	.292	.0851	10.7	3.428	11.75	.130	.0170	17.7	7.674	58.88
.646	.417	3.8	1.549	2.399	.288	.0832	10.8	3.467	12.02	.129	.0166	17.8	7.762	60.26
.638	.407	3.9	1.567	2.455	.285	.0813	10.9	3.508	12.30	.127	.0162	17.9	7.852	61.66
.631	**.398**	**4.0**	**1.585**	**2.512**	**.282**	**.0794**	**11.0**	**3.548**	**12.59**	**.126**	**.0159**	**18.0**	**7.943**	**63.10**
.624	.389	4.1	1.603	2.570	.279	.0776	11.1	3.589	12.88	.125	.0155	18.1	8.035	64.57
.617	.380	4.2	1.622	2.630	.275	.0759	11.2	3.631	13.18	.123	.0151	18.2	8.128	66.07
.610	.372	4.3	1.641	2.692	.272	.0741	11.3	3.673	13.49	.122	.0148	18.3	8.222	67.61
.603	.363	4.4	1.660	2.754	.269	.0724	11.4	3.715	13.80	.120	.0145	18.4	8.318	69.18
.596	.355	4.5	1.679	2.818	.266	.0708	11.5	3.758	14.13	.119	.0141	18.5	8.414	70.79
.589	.347	4.6	1.698	2.884	.263	.0692	11.6	3.802	14.45	.118	.0138	18.6	8.511	72.44
.582	.339	4.7	1.718	2.951	.260	.0676	11.7	3.846	14.79	.116	.0135	18.7	8.610	74.13
.575	.331	4.8	1.738	3.020	.257	.0661	11.8	3.890	15.14	.115	.0132	18.8	8.710	75.86
.569	.324	4.9	1.758	3.090	.254	.0646	11.9	3.936	15.49	.114	.0129	18.9	8.811	77.62
.562	**.316**	**5.0**	**1.778**	**3.162**	**.251**	**.0631**	**12.0**	**3.981**	**15.85**	**.112**	**.0126**	**19.0**	**8.913**	**79.43**
.556	.309	5.1	1.799	3.236	.248	.0617	12.1	4.027	16.22	.111	.0123	19.1	9.016	81.28
.550	.302	5.2	1.820	3.311	.246	.0603	12.2	4.074	16.60	.110	.0120	19.2	9.120	83.18
.543	.295	5.3	1.841	3.388	.243	.0589	12.3	4.121	16.98	.108	.0118	19.3	9.226	85.11
.537	.288	5.4	1.862	3.467	.240	.0575	12.4	4.169	17.38	.107	.0115	19.4	9.333	87.10
.531	.282	5.5	1.884	3.548	.237	.0562	12.5	4.217	17.78	.106	.0112	19.5	9.441	89.13
.525	.275	5.6	1.905	3.631	.234	.0550	12.6	4.266	18.20	.105	.0110	19.6	9.550	91.20
.519	.269	5.7	1.928	3.715	.232	.0537	12.7	4.315	18.62	.104	.0107	19.7	9.661	93.33
.513	.263	5.8	1.950	3.802	.229	.0525	12.8	4.365	19.05	.102	.0105	19.8	9.772	95.50
.507	.257	5.9	1.972	3.890	.227	.0513	12.9	4.416	19.50	.101	.0102	19.9	9.886	97.72
.501	**.251**	**6.0**	**1.995**	**3.981**	**.224**	**.0501**	**13.0**	**4.467**	**19.95**	**.100**	**.0100**	**20.0**	**10.000**	**100.00**
.496	.246	6.1	2.018	4.074	.221	.0490	13.1	4.519	20.42					
.490	.240	6.2	2.042	4.169	.219	.0479	13.2	4.571	20.89		10^{-3}	30		10^3
.484	.234	6.3	2.065	4.266	.216	.0468	13.3	4.624	21.38	10^{-2}	10^{-4}	40	10^2	10^4
.479	.229	6.4	2.089	4.365	.214	.0457	13.4	4.677	21.88					
.473	.224	6.5	2.113	4.467	.211	.0447	13.5	4.732	22.39		10^{-5}	50		10^5
.468	.219	6.6	2.138	4.571	.209	.0437	13.6	4.786	22.91	10^{-3}	10^{-6}	60	10^3	10^6
.462	.214	6.7	2.163	4.677	.207	.0427	13.7	4.842	23.44		10^{-7}	70		10^7
.457	.209	6.8	2.188	4.786	.204	.0417	13.8	4.898	23.99	10^{-4}	10^{-8}	80	10^4	10^8
.452	.204	6.9	2.213	4.898	.202	.0407	13.9	4.955	24.55		10^{-9}	90		10^9
										10^{-5}	10^{-10}	100	10^5	10^{10}
											10^{-11}	110		10^{11}
										10^{-6}	10^{-12}	120	10^6	10^{12}

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